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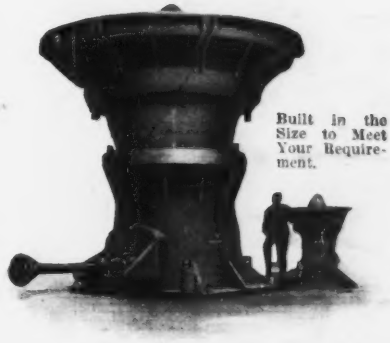

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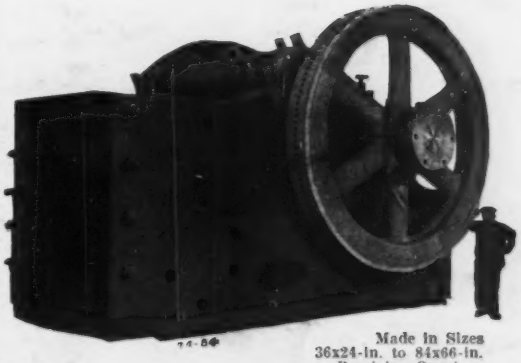

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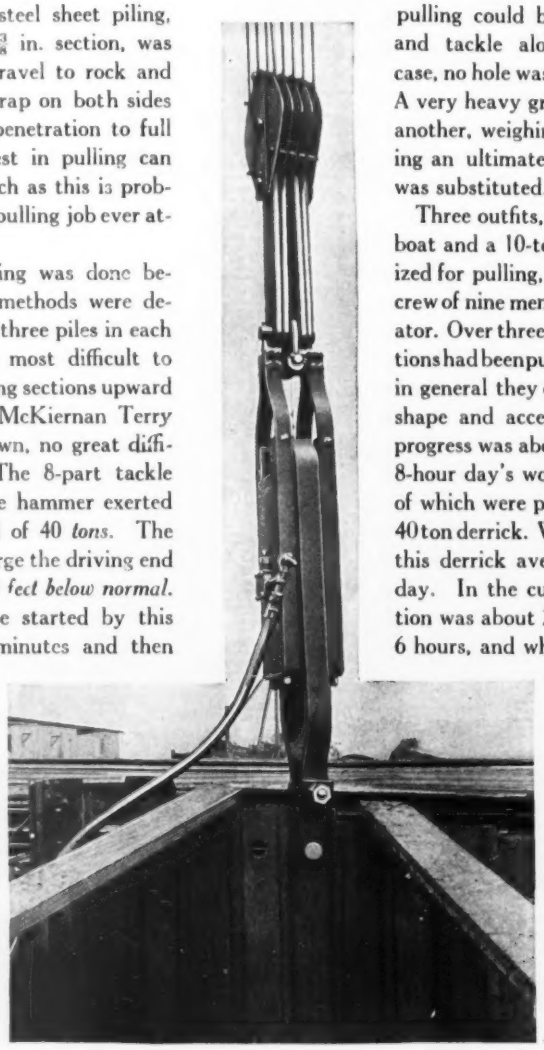
Considerable experimenting was done before the most economical methods were determined. The first two or three piles in each pocket were naturally the most difficult to start, yet by driving the piling sections upward 6 to 8 feet with 3000-lb. McKiernan Terry Hammers rigged up as shown, no great difficulty was encountered. The 8-part tackle used in connection with the hammer exerted an estimated constant pull of 40 *tons*. The pull was sufficient to submerge the driving end of the derrick boat *about* 3 *feet below normal*.

Subsequent sections were started by this method in two or three minutes and then after a piling section commenced to move freely, the hammer was removed and the remainder of the pulling done with a grip and tackle. Wherever a hammer had to be used it was attached by putting a 3½-in. hole through the top of the piling section, the holes being burned in by the oxy-acetylene process. In some instances the pulling could be accomplished with the grip and tackle alone and where this was the case, no hole was needed in the piling section. A very heavy grip was at first used, but later another, weighing about 500 pounds and having an ultimate strength of about 223 tons, was substituted.



Three outfits, a 40-ton and a 15-ton derrick boat and a 10-ton locomotive crane were utilized for pulling, and together required a total crew of nine men, including one acetylene operator. Over three-fourths of the 3100 piling sections had been pulled when this was written, and in general they came out in exceptionally good shape and acceptable for reuse. The usual progress was about 20 piles per day. The best 8-hour day's work to date was 38 piles, most of which were pulled with a grip alone by the 40-ton derrick. When pulling with the hammer, this derrick averaged about 8 or 9 piles per day. In the cut-off line, where the penetration was about 27 feet, 65 piles were drawn in 6 hours, and where the penetration was from 40 to 53 feet, 43 were drawn in 8 hours by the locomotive crane.

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Engineering News

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Combined Concrete Arch Bridge and Concrete Dam

A concrete arch bridge whose abutments form also the abutments of an arched dam was completed a few months ago at La Salle, Ill. The bridge spans a deep gorge between the Starved Rock State Park and the private estate of F. W. Matthiessen, known as Deer Park. The bridge and lake are on his private grounds, but are open to the public.

A dam about 30 ft. high was built in this gorge in 1901, and a lake was formed extending about ½ mile up the gorge. Last summer it was decided to raise the dam 18 ft. higher, making the lake more than twice its original area and about ¾ mile long. This dam forms a crescent with the arch upstream and is approximately 8 ft. thick at the base and 2½ ft. at the top. Its radius on the water side is 48 ft. The downstream face is molded in horizontal irregular ribs, in order to make its appearance harmonize with the stratified sandstone rock that forms the walls of the gorge. In doing this work, forms were placed in the usual manner, except that on the exposed face cotton cloth backed with clay, sand or any similar material was used to form the irregular surfaces seen in the photograph.

One object in raising the dam was to use the lake above for water storage To draw water from the reservoir, three outlet pipes extend through the dam at about 5-ft. intervals. These pipes have an elbow on their outer end and discharge the water on the back side of a molded ledge extending along the face of the dam. The discharge from the pipe cannot be seen from below, but the water will overflow in a thin sheet all along the ledge.

As it was desired to have a bridge to span the gorge near the dam, it was decided to use the abutments of the dam as the bridge abutments. It will be seen from the view that the arch springs apparently from the natural wall of the gorge.

The arch bridge is made up of two ribs 24 in. square at the top of the arch and 2x4 ft. at the abutment,

FRONT VIEW OF COMBINED BRIDGE AND DAM, SHOWING IMITATION OF STRATIFIED ROCK IN CONCRETE

having a radius of 40 ft. The bridge is 16 ft. wide and 160 ft. long on the floor, the span being 70 ft. for the arch rib on the lower side of the gorge and 50 ft. for the rib on the upper side. The foundations are in natural sandstone ledges.

The concrete mix was 1 : 2½ : 4, using sand and gravel of ½- to 1½-in. size. Nearly all of it was spouted into place. The exposed surfaces will be finished next spring by rubbing with sand to remove form marks. The formwork consisted of timbers 2x4 in. and 2x8 in., with matched sheathing. The parapet was cast in place, but the spindles were made by hand.

The bridge and dam were designed by O. C. Simonds & Co., landscape gardeners, of Chicago. This firm also contracted to do the work, on the cost-plus-percentage system. The construction was under the charge of F. M. Button, a member of the firm, as resident engineer.

Design and Construction Details of a Long Concrete Arch Bridge

By C. D. Hale*

SYNOPSIS—Describes the general design and the details of construction of a bridge with eight arches of 52- to 88-ft. span. Concrete handled in dump-cars and sometimes placed during severe weather. Interesting notes as to temperature changes in the fresh concrete.

The Morgan St. reinforced-concrete arch bridge across the Rock River at Rockford, Ill., will be completed this spring. It takes the place of an old wood-truss bridge. The new bridge will be 965½ ft. long over all, with a continuous grade of 3% rising from the west end. The main portion comprises eight arch spans—three of 52-ft. clear span, one of 79 ft. and four of 88 ft. Each span has two arch ribs 4 ft. wide, spaced 22 ft. apart. The bridge is 44 ft. 8 in. wide over all, with a 28-ft. roadway and two 7-ft. sidewalks. The latter are carried on cantilever brackets extending out from the spandrel columns. Fig. 1 is a view of three spans at the east end, and Fig. 2 shows the cross-section.

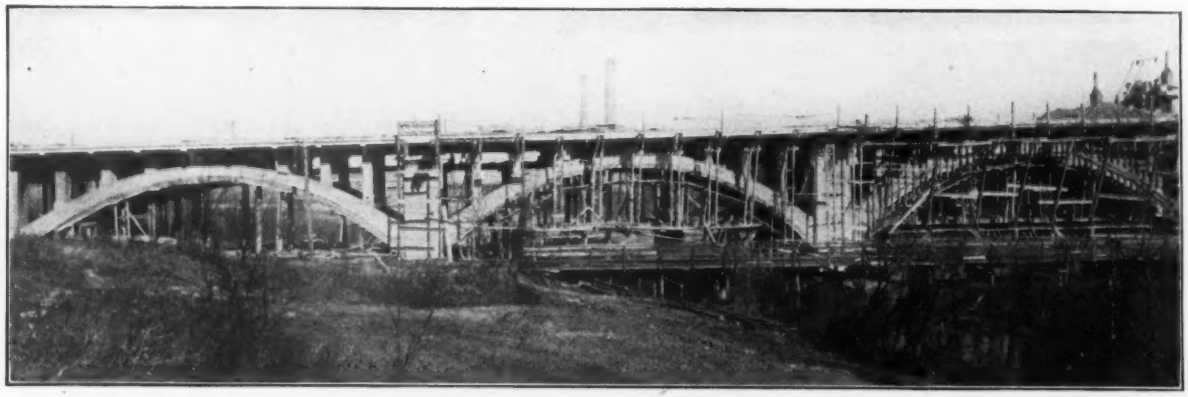


FIG. 1. CONSTRUCTION OF MORGAN ST. REINFORCED-CONCRETE BRIDGE AT ROCKFORD, ILL.

The west approach is a fill 181 ft. long, with retaining walls, followed by a 28-ft. concrete girder span. At the east end are two similar girder spans over the Chicago, Milwaukee & St. Paul Ry. The west abutment and the first two piers are on sandy clay, with no piles. The other piers and the last abutment are on gravelly soil, with pile foundations.

Design, Concrete and Details

In designing the structure the dead-load is taken at 150 lb. per cu.ft. for concrete and 120 lb. for earth-filling. The bridge is designed to carry a uniform live-load of 150 lb. per sq.ft. of roadway and 100 lb. per sq.ft. of sidewalk or a concentrated live-load consisting of a 24-ton traction engine with 16 tons on the front axle and load distributed according to the specifications of the Illinois Highway Commission. The design provides also for a temperature range of 80° F.

The following unit stresses were used: Concrete, 650 lb. per sq.in. in compression; steel, 16,000 lb. per sq.in. in tension, and in compression 15 times the unit stress in the surrounding concrete. For the arch ribs, with temperature stresses included, the unit stress is taken at 800 lb. for compression in concrete and 20,000 lb. for tension in steel. Latticed steel ribs are used in the arch ribs.

The concrete is made with local gravel. A 1:3:5 mix is used for the footings and piers up to the springing line, above which it is 1:2:4 for all the work, except that for the hand railing the mix is 1:1½:3. The washed sand, supplied by the Rockford Sand and Gravel Co., was of the following sizes: 2 to ¼ in. for abutments and retaining walls; 3 to ¼ in. for footings; 2½ to ¼ in. for piers up to sprinkling line; 1¼ to ¼ in. for all parts above springing, except ¾ to ¼ in. for the hand railings, parapets and lamp posts.

The roadway slab is 7 in. thick and has a crown of 6 in. On this will be a 1-in. sand cushion for brick paving laid with tar filler. Expansion joints are provided at the sides of each pier, with three thicknesses of tar paper in both the vertical and horizontal surfaces of the joint. The exposed surfaces of the concrete were not treated in any way, the form marks being allowed to remain. The parapet, or hand railing, is of special design and is poured in place in pressed-steel forms that can be used many times. The bridge will be lighted by 22 electric lamps mounted on ornamental concrete posts on the hand railing.

Construction Methods and Plant

The construction plant consisted of one stiff-leg derrick operated by a double friction-drum hoisting engine; one 3-ton hand-operated stiff-leg derrick; a steam-driven Austin cube concrete mixer of 11-cu.ft. capacity; a Ransome-Bantam gasoline-driven mixer, used to pour the hand rails; four Koppel steel dump-cars of 21-cu.ft. capacity; one single friction-drum hoisting engine; and two 6-in. centrifugal pumps, together with wheelbarrows, drop hammers, piledriver leads, etc. A sidetrack of the

*Assistant Superintendent for the J. J. O'Heron Construction Co., Chicago.

Illinois Central R.R. crosses Morgan St. about 50 ft. from the west end of the bridge. Therefore the cement shed and office were placed here, and all materials were unloaded at this place.

The steam-driven mixer was placed at the west end of the bridge, and a track of 24-in. gage was laid over the old bridge. The cars were operated by a cable from the single-drum hoisting engine placed at the east end of the track. The sand and gravel were wheeled to the mixer in barrows. From the mixer the concrete was hauled up in the Koppel cars by the engine and dumped into chutes placed wherever concreting was in progress. A switch was placed at the mixer, and two trains of two cars each were operated.

The work started on the retaining-wall section; and as it progressed, the old bridge was torn down and the track relaid over the completed spans of the new structure. This process was followed until four spans of the new bridge were in place. Then the mixer was moved to the east end of the fourth span, and the aggregate was hauled by team and spread over the floor of the new bridge in shallow piles. From these it was wheeled to the mixer, whence it was chuted directly into the forms of the next pier and arches. In pouring the roadway and sidewalks of the next span it was necessary to haul the concrete to place in the small cars. When this span was finished, the mixer was again moved to the end of the completed work and this process repeated for each of the remaining spans.

All the reinforcing steel was bent by hand on a bench in the steel yard and delivered to the forms ready to place. The latticed steel arches used to reinforce the arch ribs came in sections weighing about 1000 lb. each. They were lifted into place by the hand derrick, which was carried overhead on the falsework. This derrick was also used in placing the heavy timbers of the falsework shown in Figs. 2 and 3.

The arches of span No. 8 and the east abutment were poured in rather severe weather. At various places in the concrete were placed pieces of tin speaking tube, in which thermometers were inserted for the purpose of taking the internal temperatures. Unfortunately, no systematic record of these temperatures was kept, but it was noticed that the temperature increased from about 65° F. (at which temperature the concrete was placed) for about three days until it reached a temperature of 88° F. It kept this latter temperature for about 48 hr., despite the fact that atmospheric temperatures ranged from 5° to 35° above zero during this time.

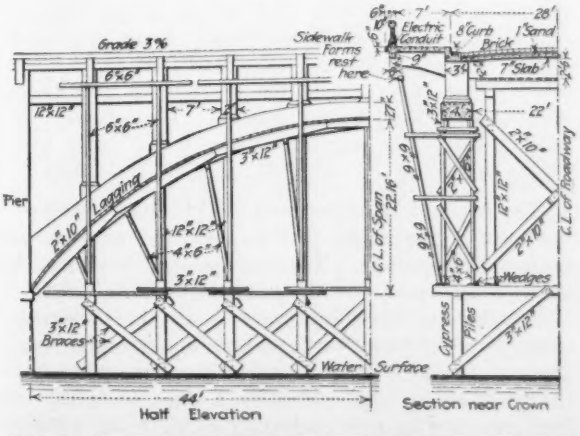


FIG. 2. ARCH CENTERING AND FALSEWORK FOR THE ROCKFORD BRIDGE

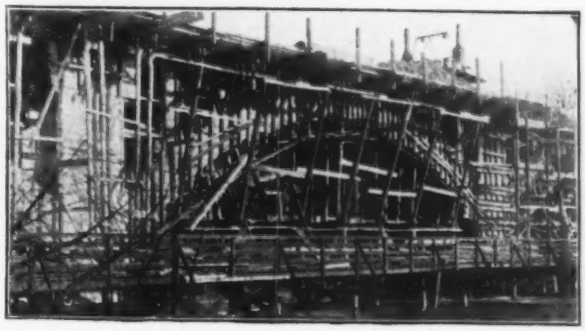


FIG. 3. FORMS AND FALSEWORK OF NEW BRIDGE, WITH TEMPORARY FOOT-BRIDGE BELOW

Only three piers of the bridge (Nos. 5, 6 and 7) were placed in the stream, the depths of water being respectively 5 ft., 15 ft. and 11 ft. At piers 6 and 7 the excavation was carried down 6 ft. and 8 ft. below the bottom of the stream. This was accomplished by the use of puddle-wall cofferdams, using 3 x 8-in. tongued and grooved sheeting 28 ft. long. The cofferdams were 16 x 39 ft. inside, with a 4-ft. puddle wall.

When the cofferdam for pier 6 was placed, it was found that about 3 ft. of riprap boulders, used to protect the foundation of the old stone pier (which stood alongside the new one) had to be penetrated by the cofferdam wall. The sheeting was set on these boulders as firmly as possible and the puddle wall filled with loam and sandy clay. The 6-in. sand pump was able to keep out the water so that the boulders could be removed, but this was not accomplished until the puddle wall had washed into the dam and been refilled several times. After the boulders were removed, the sheeting was driven down and excavation started. The excavated material was shoveled into a bucket, which was hoisted and dumped by the stiff-leg derrick that rested on the floor of the old bridge.

As the excavation proceeded, the material kept getting finer. It changed from a coarse gravel at the top to a clayey sand at the bottom. This fine material gave considerable trouble by boiling up under the sheeting and in the bottom of the dam and washing in the puddle walls, although the inner sheeting was driven 5 or 6 ft. below the excavation. This trouble was remedied by sand bags placed around the inner sheeting in the bottom of the puddle wall.

All the falsework piles were driven from the floor of the old bridge. After these were in place, the derrick was lowered to the stone pier at the east end of the old bridge and moved back over the falsework piles for the purpose of wrecking the old bridge. This was done with the aid of an oxyacetylene torch, which was used to cut the steel tie-rods and hangers. When the old bridge was closed to pedestrians, a pile foot-bridge was built, as shown in Fig. 1.

The bridge was designed by the Westcott Engineering Co., of Chicago, in conjunction with J. B. Marsh, consulting engineer, of Des Moines, Iowa. It is being built under the direction of Edwin Main, City Engineer of Rockford. The cost will be about $83,500. The John J. O'Heron Construction Co., of Chicago, has the contract for the entire work. Alexander Cross is superintendent in charge for the contractor.

Large Lumber Cableway Controlled by Waterwheels

By J. W. Swaren*

Many excellent stands of timber on the Pacific Slope are in basins not easily accessible by logging railways. A stand of this character in the basin of Spanish Flat, Plumas County, California, is owned by the Spanish Peak Lumber Co. The Western Pacific R.R. passes within 5 mi. of the mill, but a ridge rising to an elevation of 4933 ft. precludes direct rail connection.

It was impossible to build a logging railroad at a cost permitting a profitable cutting of the controlled stand of about 200,000,000 ft. b.m. A proposal to construct a waterwheel-controlled cableway was submitted to the engineers of the American Steel and Wire Co. and the Pelton Water Wheel Co., by whom the design of the cableway was developed.

Cableway Capacity 15 Tons per Hour

The length of the cableway from the main sheaves of the loading station to the discharge station is 27,200 ft. The rated capacity is 15 tons per hour, or approximately 10,000,000 ft. b.m. of rough lumber. The traction cable has a speed of 414 ft. per min., and the loads are spaced 1242 ft., or one load every 3 min. Normal outgoing loads are 1500 lb., an equivalent of 430 to 550 ft. b.m. of lumber, dependent on grade and condition. Each load is supported by two carriers, designed especially for lumber packages.

Each carrier consists of a 4-in. channel, 32 in. long, suspended by chains from an arm attached to a two-trolley cable carriage. A gripper for seizing the traction cable is attached to this arm. Sliding loosely on each chain is a right-angled malleable-iron clamp, for clamping the package. One chain is quickly detachable by a spring-actuated catch under the channel.

The lumber is loaded on buggies in suitable packages and hauled to the loading terminal, where the carriers are quickly put in place by detaching the loose chain, dropping the load clamps into place and reattaching the chain. As the buggy is stopped on a hump, pushing the buggy over the hump leaves the package suspended and firmly locked.

A gong, controlled by the main sheave of the traction cable, enables the dispatcher to space the loads accurately. On the return trip the empty carriers are spaced 621 ft.

*Hayward, Calif.

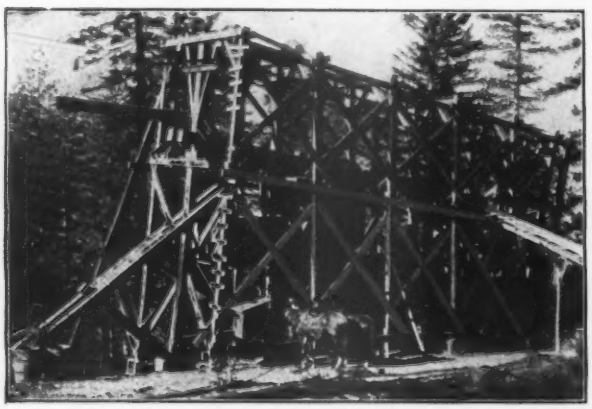


FIG. 1. DOUBLE TENSION TOWER OF CABLEWAY

It has been found that this spacing must be exactly maintained, or the slack of the traction cable will drag on high points. Supplies may be brought from the railway on the return track, the return-load limit being 600 lb.

A steel traction cable 5/8 in. in diameter, with a working tension of 35,000 lb. per sq.in., is used. Its tension is maintained by the customary weighted carriage and multiple-sheave system, installed at the discharge terminal.

The track cables are of lock-joint construction, with hemp center, the loaded track being 1 1/8 in. in diameter and the return 7/8 in. in diameter. It is expected that the track cables will not require renewal during the removal of 200,000,000 ft. of lumber.

Compensation of length for temperature changes is provided for by dividing the track cables into five sections, one end of which is anchored in concrete piers; the other, carried over rocking arms, is held in proper tension by means of a weight box. Rigid rails set in suitable structures provide transition from one section to another.

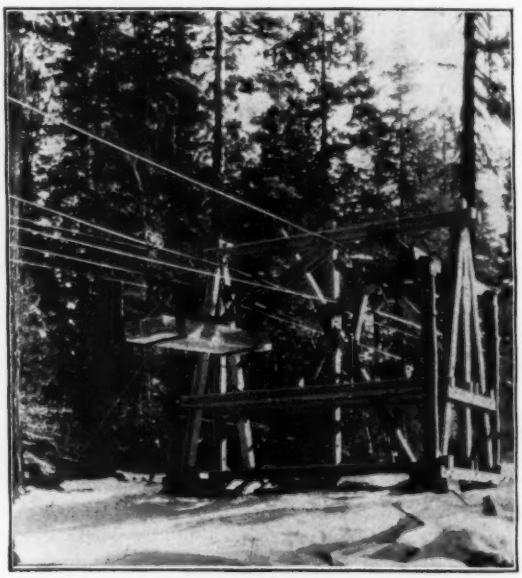


FIG. 2. TYPICAL ANGLE STRUCTURE

A double tension tower is shown in Fig. 1. The rigid rails and clearway for loads, as well as the tension chains leading from cable ends to the weight boxes, are in the upper story, while two weight boxes, one for the loaded, the other for the light track, are in the lower story. Cast steel is used for the tension and rocking arms and tension-system sheaves. Chilled-steel idler sheaves carry the traction cable. Guide arms assure proper return of the traction cable to the idlers.

Compensating Arms Used on Vertical Angles

Sixty-five structures are required to support and control the cableway. The average span is 410 ft. between structures, with a maximum span of 2810 ft. Three packages are always on this section. Forty-eight of the structures are standard towers, ranging in height from 12 to 55 ft. Compensation for vertical angles in the track cables is provided by a short piece of rigid track mounted on a pillow block rotating about a tubular crossarm.

FIG. 3. LOADING TERMINAL WITH SPECIAL ROOF

Horizontal angles are deflected by special angle towers, of which there are two. If the angle is small, curved rail structures, of which there are four, are used. A typical angle structure is shown in Fig. 2. Manganese rollers guide the traction cable into the idlers. Two double-bent and two four-bent structures are required for spanning the larger ravines.

Tension is maintained by two double-tension structures (Fig. 1), two double anchorage structures and one combination anchorage and tension station. Special structures are built for the terminals, to shelter the operating force and equipment and to provide suitable tracks for loading and unloading. All structures are designed to permit a package length of 32 ft. This provision resulted in the novel roof design, shown in Fig. 3, of the loading terminal. The overhang covering the cable service tracks had to be constructed as a cantilever, so a very steep pitch was required to prevent an excessive snow load.

As the discharge terminal of the cableway is 890 ft. lower than the loading terminal, computations indicated that not only would the cableway operate by gravity, but an excess of 12 hp. would require absorption by some type of brake. Similar computations indicated a starting torque requiring 20 hp. Operating results have proved these computations reasonably accurate, although due to variations of slack in the track cable, excess power is not developed continuously. Instead, the water-motor set installed as a brake really acts as a governor, in irregular and frequent cycles, alternately absorbing and generating power.

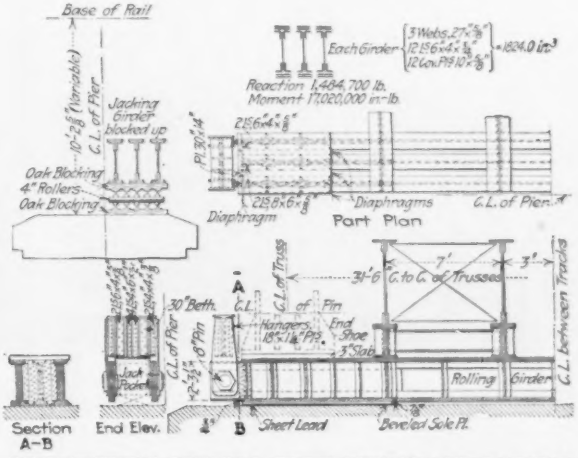
The main, or grip, sheave is 8 ft. in diameter and turns at 16.42 r.p.m. It is fitted with a hand-operated band brake. The vertical shaft of the main sheave is connected by a belt, countershaft and bevel-gear combination to the control unit. This consists of two 24-in. Pelton water motors, rigidly connected in opposition by a solid coupling. The governing is accomplished by needle nozzles, with the needles actuated by direct-motion oil-pressure governors. With the wheels connected in opposition, the buckets of one unit face in the opposite direction to those on the other. The governors are so adjusted that when the cableway slows below normal, water is admitted to the driving unit, and power is developed. When the speed rises above normal, water is shut off from the power wheel and admitted into the braking wheel, and the faces of the buckets (this unit revolves against the normal) strike against the jet, the impact absorbing the excess power of the cableway.

Each governor is supplied with oil by a Pelton positive-displacement pump, belt-driven from the crowned face of the coupling between the water motors. Speed regulation of 10% (5% either side of normal) was guaranteed and has been performed.

Bridge Pier Girders with Beveled Bearing Plates on Masonry

The new main spans of the Union Pacific R.R. bridge over the Missouri River at Omaha rest on heavy distributing girders extending lengthwise along the tops of the old piers. To prevent undesired concentration of the reaction pressure near the ends of the pier masonry, a special form of bearing cushion was placed under these girders.

As described in *Engineering News* of Jan. 18, 1917, p. 122, the four spans (246 ft. 3 in. each, c. to c.) were erected on falsework alongside the old bridge and were rolled into place when the old spans were rolled out. The shoes and pier girders were erected as part of the new spans, and the girders formed the upper roller track. When the new spans were in place on the piers, the



DISTRIBUTING GIRDERS, WITH TEMPORARY JACKING ATTACHMENTS ON OMAHA BRIDGE

girders were again utilized as means for applying the pressure of jacks to lift the spans while removing the rollers, and for lowering the steel work to bearing on the masonry piers below.

The sketch herewith shows one of these girders, and indicates the jacking yoke at the end and the pier bearing plate on the masonry. On each pier are two girders, one for each span, set close side by side. Each girder is made up of three 27-in. plate-girder ribs 34¼ ft. long, connected by transverse vertical diaphragms. The truss shoes rest on it by a 3-in. steel slab extending over all three ribs. The jacking yoke is pinned to end extensions of the two outer ribs; a strong diaphragm just inside the jack pocket transfers the load of the center rib to them.

The bearing plate under each end of each girder is a ⅞-in. steel plate about 9 ft. long, wide enough to take all three ribs. It is beveled ⅛ in. in thickness, being only ¾ in. thick at its outer end. A sheet of lead between plate and masonry furnishes a cushion. The plate being thicker near its inner edge, the load on the masonry is expected to distribute in such a way as to have its maximum intensity at this edge.

The new spans were erected and placed by the American Bridge Co., under the general direction of E. E. Adams, Consulting Engineer, R. L. Huntley, Chief Engineer, and W. L. Brayton, Bridge Engineer, Union Pacific R.R.

Building Bridge Piers in the Mississippi River

By C. F. Womelsdorf*

SYNOPSIS—Describes the foundations, with construction methods and plant, of the new cantilever bridge at Burlington, Iowa.

The new highway bridge over the Mississippi River for the Citizens Bridge Co., at Burlington, Iowa, has a cantilever channel span of 480 ft., with anchor-arm spans of 260 ft. each. There are five concrete piers, and some views herewith show different stages in their construction. Three of the piers have pile foundations, while the others are founded on rock. The general design of the two channel piers is shown in Fig. 4. Each consists of a pair of reinforced-concrete pedestals, panelled on three sides and connected by a 12-in. curtain wall, or diaphragm. The two piers for the anchor arms are similar; but one of these (No. 2) is on rock, as is the adjacent smaller pier (No. 1) for the west approach span. The reinforcement is of structural steel. The piers for the east approach (girder and deck-truss spans) are pairs of steel cylinders placed over foundation piles and filled with concrete. The two cylinders are connected by bracing, as shown in Fig. 5.

Fig. 1

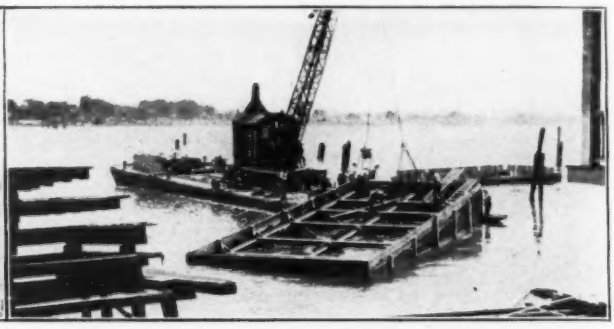


Fig. 2

FIGS. 1 AND 2. LAUNCHING AND HANDLING PIER CRIBS FOR NEW MISSISSIPPI RIVER BRIDGE AT BURLINGTON, IOWA

The substructure was finished Dec. 2, 1916, 10 days ahead of any serious freezing weather, and despite the fact that the long and almost continuous period of high water (from Jan. 10 to July 1, 1916) prevented doing any work in the river early in the season without incurring unusual expense and risk.

Pier Excavation

The excavation for the west pier, No. 1 (founded on solid rock), was carried on by the ordinary cofferdam process. That for Pier No. 2 (also on rock) was done with a 1½-yd. clamshell bucket, a larger area than the size of the crib being cleared off so that it could be set in place on the rock. This excavation was quite troublesome on account of having no orange-peel bucket available to handle the boulders and loose rock overlying the solid rock. And on account of the sand washing in from the upstream side it was necessary to handle quite a little excess material.

No excavation was necessary at Piers Nos. 3 and 5, but at pier No. 3 (channel span) it was found that the bed of the river had scoured out during high water. This was replaced with riprap carried well out beyond the pier. The crib was then landed on the stone. This crib, like all the others and like the tubular piers exposed to the strong current of the river at time of high water, was well protected with riprap. Pier No. 4 (channel span) was first landed in position on the bed of the river, and the sand was then pumped out until it settled to the proper elevation.

Very little excavation was necessary for any of the cylinder piers. It was found, however, that the sand under the surface at the first three of these piers (at the shore end of the east approach) would not sustain the weight of the steel shells. It was therefore necessary to drive four piles at each pair of tubes, crosscap them and frame up under the top strut between the tubes, in order to hold them in position until the concrete could be run.

The cribs and cofferdams were all built in the yard on the Iowa (west) shore. The cribs were built and launched from ways, after which they were towed to their proper positions or tied up until wanted. Fig. 2

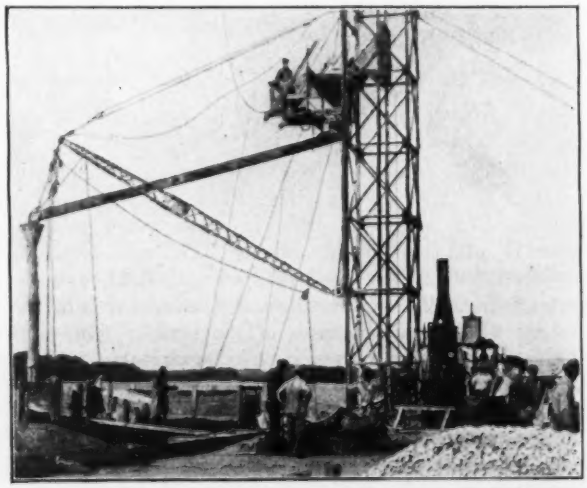


FIG. 3. TREMIE CONCRETING IN CRIB OF PIER 4

*Resident Engineer, Wisconsin Bridge and Iron Co., Burlington, Iowa.

shows this part of the work. The ends and sides of the cofferdams were framed separately, so that they could be used over again where size permitted. These parts were launched from the ways, after which they were floated to place as desired. The cofferdams were made of two

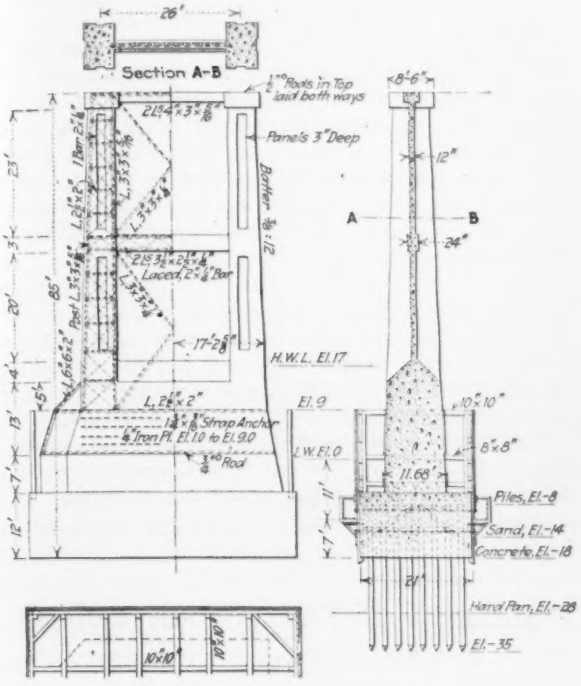


FIG. 4. PIER FOR THE CHANNEL SPAN OF BURLINGTON BRIDGE

Showing the structural steel reinforcement

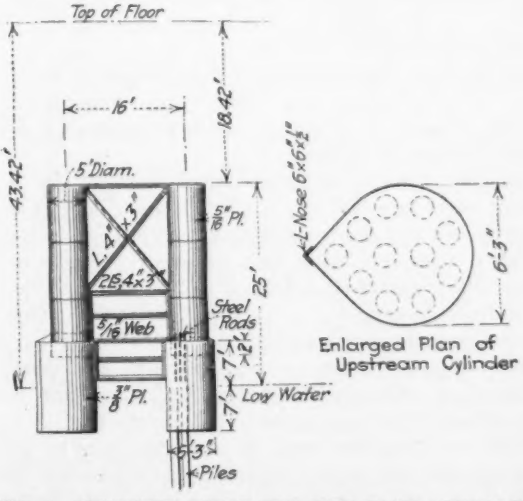


FIG. 5. CYLINDER PIERS FOR THE EAST APPROACH OF THE BURLINGTON BRIDGE

thicknesses of 1-in. lumber with tar paper between. The cribs and all bracing were of 8x8-in. pine.

In sinking the cribs, boxes were built on top of the cofferdams at each end. These were loaded with crushed stone, which was afterward used for concrete. This arrangement was used instead of the stone boxes on the sides, as shown in Fig. 4. The joint between the crib and the cofferdam was made tight by calking with oakum. In each case, however, the material worked loose

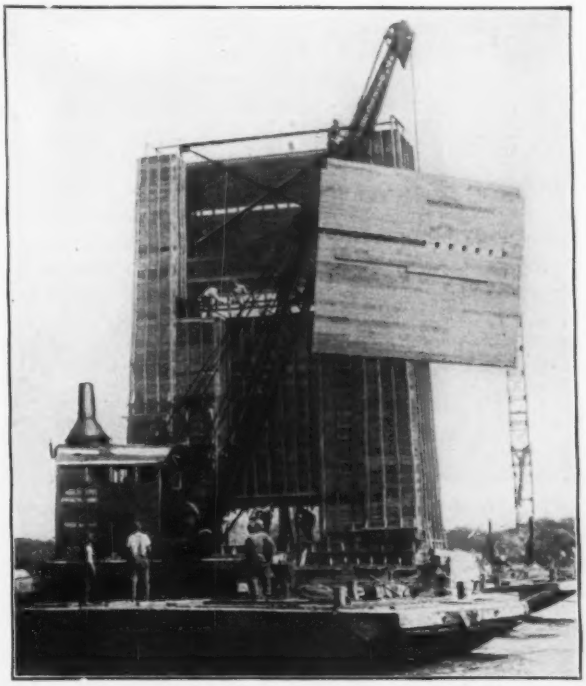


FIG. 6. SETTING PIER FORMS IN LARGE SECTIONS

and the joint opened, so that it was necessary for a diver to go over the calking and stop the leaks when the pumping was started. All the pumping was done with an 8-in. centrifugal pump, which was of more than sufficient capacity.

Each crib was held in position by a cluster of four piles about 10 ft. above and below it, from which cables were fastened to the four corners. The piles were then driven inside the crib, before it was sunk. The cribs floated about 3 ft. above the surface of the water, and after being securely fastened they were used to lay off the spacing for the piles. By this means the pile driving could be done very accurately; and although some of the piles were followed below the surface of the water and skewed off under the crossbracing, no great difficulty was experienced from this cause when the cribs were sunk. It was found that the cribs, when landed on the bottom, were practically in their correct positions.

Driving Foundation Piles

The piles were of timber, 35 to 40 ft. long. The penetration varied from about 15 to 30 ft. They were all driven to sustain a load of 15 tons each, according to the *Engineering News* formula, although some of them brought up very hard and were driven practically to refusal. The sand varies from 8 to 10 ft. deep and is underlain with a blue shale, or hardpan, which is directly on the rock. All the piles were driven well into the shale. A Vulcan special steam hammer, having a stroke of 36 in. and striking parts weighing 3000 lb., was used to do the driving. This hammer was fitted in a steel frame, so that piles could be driven about 4 ft. below the ends of the leads without using a follower.

The pile driving for the tubular piers was all done before the tubes were set in position; and although some of these piles were driven down by a follower to the cut-off level below the surface of the water, very little trouble was experienced in placing the steel tubes in position.

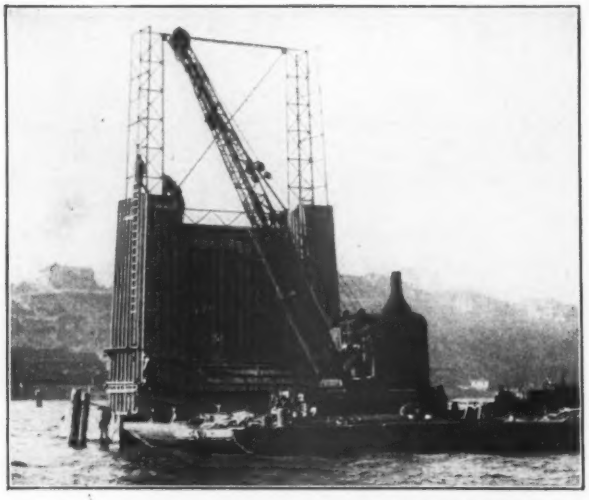


FIG. 7. STRUCTURAL-STEEL REINFORCEMENT OF CHANNEL PIERS

A good deal of triangulation work was necessary, however, and care was exercised to check up the centers as the driving was carried on.

All the concrete below water in the tubular piers, and in the main piers to within 6 ft. of low-water mark, was run through 10-in. tremies of No. 16 galvanized iron (Fig. 3). These were 15 to 30 ft. long. When first used, they were suspended from the boom of the hoisting tower by a line running direct to the drum of the hoisting engine. Later it was found that this direct connection was unsatisfactory; and a pair of double blocks was put in, in order to keep better control of the elevation of the tremie, which had to be gently raised from time to time and at the same time not raised so far as to allow all the concrete to run out of it.

It was sometimes difficult to keep the tremie full of concrete and not run it over, but with the exercise of care and by tapping the side of the tremie this difficulty was soon overcome. The concrete deposited under water was a 1:2:4 mixture, that above water a 1:2½:5. The forms were of 1-in. lumber, with 3½x6-in. studding

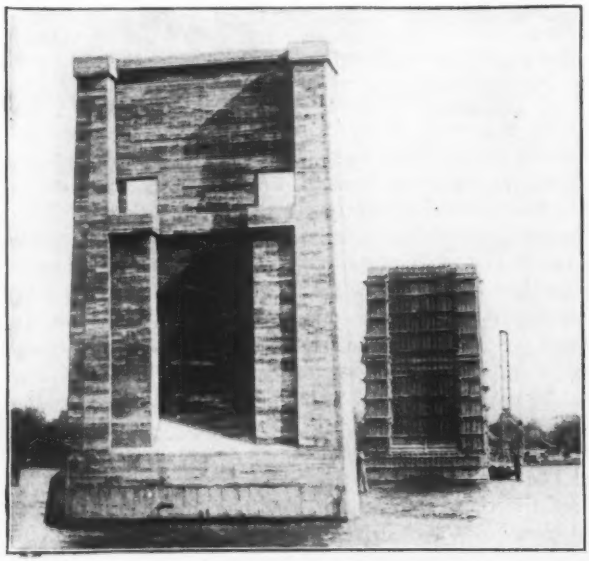


FIG. 8. FINISHED CHANNEL PIER

tied across with No. 10 annealed wire, which was kept tight by using eye-bolts. These bolts were placed between two 3½x6-in. wales spaced about 5 ft. c. to c. As piers Nos. 3 and 4, and Nos. 2 and 5 were alike, the forms were used over again.

Construction Equipment

A 20-ton Browning locomotive crane with a 50-ft. boom was used for handling the cribs and cofferdam, for setting up and taking off the forms and for setting up the pier plates and the structural reinforcing. This hoist was mounted on a track, in the center of a scow 24x86 ft. It was fitted with 60-ft. leads having a 21-ft. reach and was used for all the pile driving. When handling the cribs and setting up the cofferdams, an additional derrick scow having a 50-ft. boom was necessary.

The concrete scow, 19x100 ft., was fitted with a 20-hp. double-drum Lidgerwood hoisting engine, a No. 12 Smith mixer and an 80-ft. Insley tower. The material was all delivered on separate scows, of which there were two 20x110 ft., two 16x60 ft. and one 18x110 ft. The material was wheeled from these scows to the mixer.

The Wisconsin Bridge and Iron Co., of Milwaukee, Wis., is in charge of the design and construction, and the writer is resident engineer for the company. The contractor for the substructure is Adolph Green, Green Bay, Wis.

Worcester's 35-Year Grapple with the Sewage-Disposal Problem

By W. L. Butcher*

Recent agitation to compel Worcester, Mass., to discharge a more highly treated sewage effluent into the Blackstone River (*Engineering News*, Feb. 1, 1917, p. 213) suggests a review of the history of sewage disposal in Worcester for the past 35 yr.

About 1881 the condition of the Blackstone River became such as to lead to a report by the State Board of Health, Charity and Lunacy, which recommended downward filtration through sand.

In 1884 the city engineer visited Europe. In 1886, acting under an order by the City Council, the city engineer made a report recommending chemical precipitation. Definite steps were taken soon afterward, because of an act of the legislature in 1886 directing the city "to remove from its sewage . . . the offensive and polluting properties and substances therein, so that after its discharge into said river . . . it shall not create a nuisance or endanger the public health." Four years were allowed for the completion of the works.

Land was purchased, and the construction of an intercepting sewer was started before a final decision was made as to the method of treatment to be adopted. In 1889 the construction of a series of settling tanks was started and provision made for caring for the sludge, the adoption of further methods of treatment still being held in abeyance. In 1890 the method of chemical precipitation, then so common in Europe, was definitely adopted, and the necessary works for treating the sewage were put into operation on June 25 of that year.

The plant as first constructed had a nominal capacity of 4,500,000 gal. per day and was inadequate for the

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treatment of the entire sewage of the city, because the sewage was mingled with a large brook, the average combined flow being from 12,000,000 to 15,000,000 gal. per day. The city therefore began the enlargement of the plant in 1892, completing it in 1893.

While the enlargement of the plant made it possible to treat all the sewage during dry weather, the large quantities of brook and storm water tributary to the sewer system, together with the growth of the city, so increased the flow in times of wet weather that there were frequent storm overflows of mingled sewage and rain water. Furthermore, although the process adopted was capable of removing nearly all the suspended matter, it could not greatly reduce the dissolved organic matter. In 1895 a suit was brought against the city to secure a more complete enforcement of the provisions of the mandatory statute of 1886.

The result of this litigation was the amplification of the treatment plant and the construction of the "separating system." This system includes intercepting sewers by means of which the sewage can be collected before its discharge into the large brook previously mentioned, and the separation of sewage and also storm water in a substantial portion of the city.

In 1896 a thorough investigation of methods of dewatering sludge was undertaken, including many experiments with a large filter press, to determine the practicability of this machine for dewatering the sludge that had previously been disposed of by running it out into sludge lagoons, allowing it to dry and ultimately hauling it to adjacent farms, at the expense sometimes of the city and at others of the farmers. As a result of these tests a plant for dewatering the sludge by means of filter presses was built and was put into use in 1898.

After prolonged experiments with small sand filters to determine their efficiency under conditions encountered at Worcester the city began the construction of sand filter beds in 1898, to supplement the chemical treatment. The area of these filters was increased gradually until in 1915 it amounted to 72.6 acres.

Legally the city has occupied a unique position with respect to the sewage-disposal problem, because the original statute of 1886 was mandatory and provided that "the Supreme Judicial Court . . . shall have jurisdiction in equity to enforce the provisions of this act, by injunction or by any other appropriate remedy. . . ." In response to the action brought against the city in 1895 the court ordered the city ". . . effectually to remove from its sewage . . . the offensive and polluting properties and substances therein, so that after its discharge . . . it shall not create a nuisance or endanger the public health, and the respondent shall proceed with due diligence in obeying this decree."

The city has made extensive enlargement of the sewage-treatment plant, in addition to the construction of the "separating system," in pursuance of this order. It has been maintained with much confidence, by the city, that the original statute removes it from the jurisdiction of the State Department of Health and that it is acting directly under the jurisdiction of the court and that proceedings against it must be made through the court or by special legislation supplementary to the mandatory act of 1886.

From the beginning of the operation of the chemical-treatment plant, continuous experimental work has been carried out, chiefly upon a very large scale, to determine the practical results of the methods in use for the treatment of the city's sewage, and of all other methods which have been proposed from time to time and which seemed to give sufficient promise to warrant thorough investigation. About the year 1900, when so much attention was being given to septic-tank treatment, one of the large settling tanks was converted into an open septic tank, a large portion of the sewage subsequently to be filtered being passed through this tank, which was continued in practical as well as experimental use for several years. The results of these experiments, as well as numerous others made upon a similar scale, failed to give sufficient promise to warrant the adoption of this method.

In 1904, experiments were begun with contact beds, which demonstrated that this process is capable of effectively treating the Worcester sewage. The results, however, were not sufficiently encouraging to warrant its adoption.

In 1906 the contact beds were replaced by trickling filters of somewhat larger size, built of broken stone. These filters demonstrated their capability of producing a satisfactory effluent and of being entirely practicable for use under the conditions existing at Worcester. Beginning in July, 1911, the sewage applied to them was first passed through an experimental Imhoff tank. The experiments with the trickling filters and the Imhoff tanks were among the most exhaustive of any that have been carried out in this country and included studies of distribution by various kinds of nozzles, leading to the development of the Worcester nozzle. An exhaustive report was made in 1912, covering these experiments and presenting the following conclusion:

> The cost of operation of Imhoff tanks and sprinkler filters, per million gallons of sewage treated, would be very much less than the cost of operation of chemical precipitation or sand filtration as carried on at Worcester.

The results of these investigations are of great local value because of the necessity of soon adopting some of the more modern methods of sewage treatment, as the available land suitable for the extension of the sand filters already is limited in area.

The Worcester sewage-disposal problem has just come to the front again through further agitation by residents of the Blackstone River Valley below the city, who are attempting to secure legislative action requiring a more effective treatment of the sewage. The State Department of Health has filed a report recommending legislative action.

Before deciding upon a definite procedure, however, the city desires to conduct experiments with the activated-sludge process, which has been developed since the experimental work previously described was completed.

The original works were planned and constructed under the direction of the late Charles A. Allen, city engineer, who called in consultation the late Dr. Leonard P. Kinnicutt, of the Worcester Polytechnic Institute, to advise upon the chemical phases of the problem. The extension to the original plant was built in 1892 and 1893 under the immediate direction of Frederick A. McClure, who has been city engineer from 1892 to date. Certain of the information contained in this article has been furnished by Harrison P. Eddy, now of Boston, who had immediate charge of the Worcester sewage-works for about 15 yr. and who was responsible for developments until 1907. He was succeeded by Matthew Gault, who has also kindly reviewed this article.

Building 360 Miles of Roads with County Day Labor

By J. S. Bright, Jr.*

San Bernardino County, California, containing approximately 22,000 sq.mi., is probably the largest county in the United States. It has an assessed valuation of about $60,000,000. In October, 1914, road bonds to the amount of $1,750,000 were voted. This sum was subsequently increased to $1,813,000 by the premium received on the sale of the bonds. Funds were thus provided for the improvement of 87½ mi. of road with concrete pavement, 100 mi. with macadam pavement, and for 170 mi. of oiled or graded desert road.

This work was under the direction of a commission of three members appointed by the supervisors of the county prior to the bond election. As soon as the bonds were approved by the voters, the supervisors made an appropriation from the general funds of the county for preliminary surveying, and plans and specifications were prepared for 30 mi. of road. The bond money was not deposited with the county treasurer until Apr. 1, 1915.

The specifications called for a 1:2:4 concrete pavement 16 ft. wide and 5 in. thick, with an asphaltic oil top. Contrary to the usual California practice, expansion joints were provided (30 to 75 ft. apart). The specifications for the macadam road stipulated one course of crusher-run rock with an asphaltic oiled wearing surface, totaling 16 ft. wide and 5 in. thick.

While the preliminary survey and preparation of the specifications were in progress, the commission advertised for bids on rock, sand, cement, and rock machinery. Each bidder on rock submitted a sample for testing; and because of the variation of weight in different available rocks, the bids were received on a cubic-yard basis. In allotting the contracts for rock, the roads were divided into independent sections controlled by the nearest railroad delivery point, which determined the freight rate and wagon haul. This resulted in the contracts being divided among three firms. One rock accepted weighed 2430 lb. to the cubic yard, another 2650 and a third 3000 lb.

*Engineer, San Bernardino County Highway Commission, San Bernardino, Calif.

Having three separate sources of supply proved fortunate, because of breakdowns and car shortages. One plant was able to furnish 40 cars of crushed rock per day. The cement contract was awarded to one company, but this company had connections with four railway lines without switching charges.

Bids were received on all necessary small tools, plows, scrapers, graders, wagons, unloading chutes, pipe, mixers and rollers. Most of the time additional equipment was rented; and this practice was generally found as economical as to purchase, when depreciation charges were considered. These preliminary steps enabled the highway commission to organize its first construction crew two weeks after the money was deposited in the county treasury.

Roads Constructed with County Day Labor

The reason for adopting the day-labor plan over the contract system of construction was the result of preëlection promises. The promise had been made to local laborers and teamsters that, if the work could be done by day labor at or near the same cost as under the contract system, one or more day-laborer crews would be organized.

FIG. 1. MOUNTAIN ROAD IN SAN BERNARDINO COUNTY, CALIFORNIA

To test the economy of this method, bids were called for on 15 mi. of road, and three crews on the day-labor plan were employed on 15 mi. of similar road. When the bids were received, they were higher than expected, and only 3½ mi. of the 15 were done by contract. The cost of the work then under way by the county crews indicated that the day-labor plan could be made as economical as the contract system.

The commission then decided to do the remainder of the work by day labor. By following this plan the general business of the county was stimulated, giving the idle population work during quiet times. Of the $1,813,000 expended, it is estimated that at least $1,513,000 passed directly into the hands of San Bernardino County citizens and corporations.

In the organization of the construction crews it was found necessary to maintain camps for the crews on the mountain and desert roads only. In the valleys the jitneys proved a flexible transportation system for the employees. It was generally possible to get plenty of teams within two miles of the work.

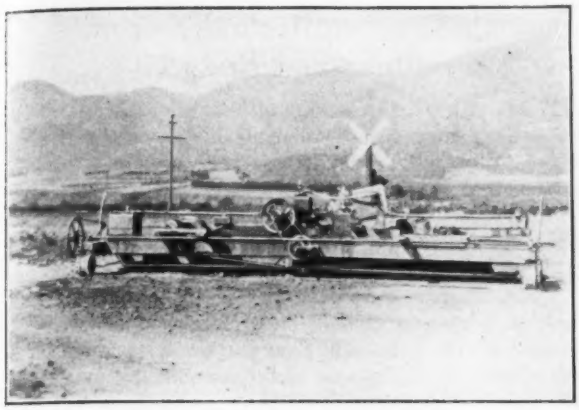


FIG. 2. CARR'S MECHANICAL TAMPER, USED FOR FINISHING 10 MILES OF CONCRETE ROAD

The rock and cement were hauled by teams or trucks, depending upon the lowest bid per cubic yard. The unloading was generally let by contract with the carload as the unit.

Concrete-Road Construction

The organization of a concrete-pavement crew was as follows: One superintendent and timekeeper, one grading foreman, one form setter, one concrete foreman, one mixer operator, one roller operator, two pumpmen, 25 to 40 laborers. Teams were required approximately as follows: Four "4-up" Fresno teams, one "4-up" plow team.

In curing the concrete it was found best in summer to cover it first with about 3 in. of earth. This covering was kept wet for two weeks. The traffic was then turned on for another two weeks, after which about 2 in. of the covering was removed by a road grader. The remaining inch of covering was left on indefinitely until blown away by the wind. This gradually exposed the concrete to the hot sun, but allowed it to dry out slowly. Wherever this method was followed, no trouble was experienced with the pavement buckling.

The method of not covering the pavement, but making small dikes around limited areas and keeping the surface constantly submerged with water, is not good practice in Southern California in hot weather, for the top $\frac{1}{16}$ in. of the concrete takes on a chalky appearance.

A Carr's mechanical tamper was used for surfacing about 10 mi. of the concrete road. This machine was one of the first put out by Mr. Carr, and his later machines are much improved. This method gives a good dense concrete and makes a superior finish in comparison to hand tamping. It is advisable to employ a first-class operator to manage the machine, as most of the difficulties experienced came from inefficient operators.

The asphaltic-oil top was handled by a separate crew, for it was best to turn the traffic on the concrete for several months and thus grind off the laitance before applying the top. The concrete was given two oil coats of 0.25 gal. per sq.yd. each.

Macadam-Road Construction

The macadam construction work was organized under a superintendent who had supervision over three or four crews on separate roads. Each crew had a foreman to attend to the subgrade, rolling and applying the screenings. The superintendent generally had only one grading crew, which he moved from one road to another as circumstances would permit. Wherever there was any considerable quantity of grading, this work was done in advance, to allow the infrequent rains to assist in the settlement of the material.

The rollers were worked to their full capacity by equipping them with headlights and working them three 8-hr. shifts. "Prest-o-lites" were used on the steam rollers, and the gasoline-engine-operated rollers were provided with electric headlights. The current was generated by belting a Ford magneto to the flywheels. These gave a very bright steady light, the flywheels having a fairly constant speed. A roller thus equipped is shown in Fig. 3. A spotlight was riveted to the frame of the steering roll and was thus automatically adjusted to the road.

The construction crews attended to giving the macadam pavement the first coat of oil before it was opened for traffic. Two coats were put on, ranging from 0.4 to 0.5 gal. per sq.yd. The oil used on both concrete and macadam was 90% asphaltic oil, heated to 400° F. and applied by a motor-truck distributor under a pressure of 30 lb. per sq.in. The state oil-heating plant at Etiwanda, San Bernardino County, was used by the commission. This is an uptodate plant in every detail, and the oil was heated for from 1 to 4c. per bbl., according to the amount the truck could handle. The oiling is costing to date from $300 to $400 per mi. per coat, depending upon the cost of sand and screenings.

Promoting Efficiency—Bonuses for Concrete Men, Etc.

Efficiency was promoted and dead timber removed from the organization by careful daily-cost comparison. An efficiency engineer was employed for the first three months. The timekeeper reported to him daily, and each month a careful comparison of unit cost on similar classes of work was made. Proper cost standards were soon established; and if any foreman exceeded the limit, he was given a chance to explain, generally followed with his time.

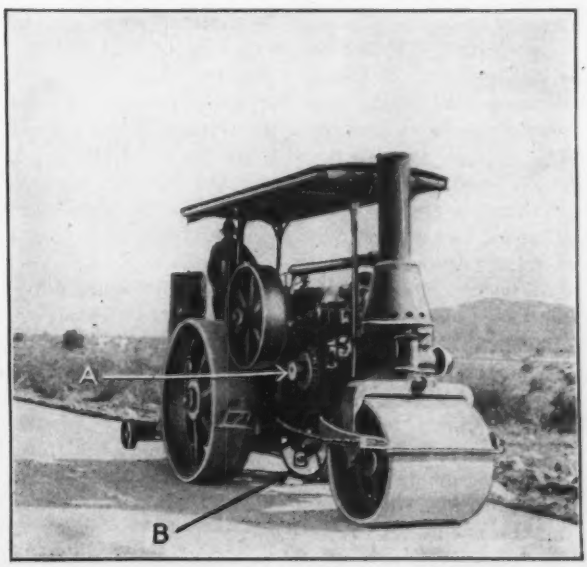


FIG. 3. ROAD ROLLER EQUIPPED FOR NIGHT WORK
A is a Ford automobile magneto; B is spotlight on roller yoke

The commission has employed as many as 10 superintendents at one time, each with from one to four crews under his charge. If portions of the county had been neglected and the operations bunched, five superintendents could have handled the work.

Further to promote efficiency, a bonus was paid to the concrete crews; but they were not permitted to do over a certain amount per day, and the foreman and mixer operator were not allowed to participate in the bonus. These last two were omitted in order that the work would not be improperly done in order to earn a bonus.

The best organized crew, in good weather with no machinery breakdowns, could complete 2 mi. of concrete base per month. The macadam crews, when working with lime rock, could also complete 2 mi. per month.

Savings could probably have been made if small portable sand-washing and gravel-screenings plants had been used from the start. A smaller number of crews would probably have been more efficient; but in public work each community had to be considered, and none wanted to be left until the last.

The completed roads have cost the county from $8800 to $12,000 per mi. for concrete, and $5000 to $10,000 per mi. for macadam. The work has not been completed as soon as expected, because it was found economical to crush with portable crushers some of the rock from field stone on a stretch of about 12 mi. This crushing was done by contract. Otherwise the 187½ mi. of road, outside of the oiling, which is held back for hot weather, would have been completed in 16 instead of 19 months.

Low Hauling Costs—Officials

The greatest saving was made on hauling of material. At the outset a trucking firm made a very low bid per ton-mile, as follows: Up to and including 1 mi., 18c. per ton; 1½ mi., 24c.; 2 mi., 31c.; 2½ mi., 37½c.; 3 mi., 43½c.; 3½ mi., 49c.; 4 mi., 54c.; 4½ mi., 60c.; 5 mi., 65c.; 5½ mi., 69c.; 6 mi., 75c.; 6½ mi., 80c.; 7 mi., 86c.; 7½ mi., 90c.; 8 mi., 96c. per ton.

The firm that took the contract at these prices could not handle all the hauling, but local teamsters attempted a large part at the same price. In some instances the price had to be raised to keep the material moving. The transportation of 4000 tons on an average haul of 8 mi. for 75c. per ton was the cheapest hauling. This work was done with teams, and the route was over a new concrete pavement that had an average downgrade of 1½%, though two short hills had to be climbed. A "4-up" team handled a train of five 3-cu.yd. wagons. The teamster used a pinch bar to help the team start the load. The average cost of hauling has been found not to exceed 20c. per ton-mile.

San Bernardino County was fortunate in having three exceptional men to look after the general details of the work: J. B. Gill, former Lieutenant-Governor of the State of Illinois, was chairman of the commission; George Hinckley, an able engineer and city manager of Redlands, Calif., represented that community on the commission; and W. A. Freemire, a banker, the third member, represented the western portion of the county. The author was chief engineer and had active charge of all the operations of the commission. The members of the commission were subject to many annoying details in allowing claims, from which they would have been free if the contract system had been adopted.

Sinking Concrete Cylinders Under a Philippine Bridge

The road and bridge system of Tayabas Province, P. I., was badly damaged by a typhoon a little over a year ago, and has since been returned nearly to normal. The reconstruction of the Dumacaa bridge—one of the larger structures wrecked—has several noteworthy features, which are described by A. T. Sylvester, district engineer, in the *Quarterly Bulletin* of the Bureau of Public Works.

The main span of the Dumacaa bridge is a 100-ft. steel through bowstring truss. There is also a 20-ft. reinforced-concrete span. The floor surface is concrete. The east abutment was on rock and was undisturbed, but the pier and west abutment, founded on sand and gravel, were undermined.

The reconstruction plans called for a new pier and a new abutment—each carried on two concrete cylinders. The original superstructure was put back in place, but 26 ft. west of its former position, on the old center-line, and about 6 ft. higher than the old elevation. The east abutment was carried up to the required height.

Two sets of forms were made for the reinforced-concrete cylinders—which were precast—one 13 ft. long and the other 10 ft., 2x4- and 2x6-in. lauam lumber being used. The outside form had a batter of 1:120 to reduce friction, which necessitated splitting all the staves. The outside form was built in two pieces, the inside one in four to facilitate removal. The cutting edge, shod with a small angle iron, had an inside bevel of 60° from the edge of the angle to the full 8-in. thickness of the cylinder. First, the inside form was erected, then the reinforcing steel and the outside form, following which the concrete was poured.

The cylinders were allowed to set for 21 days, being kept thoroughly wet down during that period. A longer time could not be allowed, owing to the necessity for getting the work done before flood time. The two pier cylinders were rolled into the river and dragged into position by a hoisting engine, being spotted by two 5-ton hand differential hoists. Rock was encountered at once, and the entire excavation in these cylinders was in rock, which was loosened by chisels, loaded by divers (with helmet only) into buckets and hoisted out. There were two of these buckets, made by the blacksmith, of sheet iron having wooden bottoms. Each held about 2 cu.ft.

Excavation in the abutment cylinders was easier. Two divers—using a half of a cocoanut shell and their hands—were able to load 11 buckets of sand per shift.

The average rate of sinking, including the necessary building up, was 1 ft. per day. For building up the cylinders as they were sunk, one set of original forms was cut in half to reduce weight, and four holes were left near the top of the section last cast. In these holes ¾-in. bolts were inserted to support the forms, no guide piles or falsework being used.

The abutment cylinders were sunk 19¼ ft. below low water and were filled with concrete. Two or three days later the pier cylinders reached their final depth of 15 ft. In each instance a seal of concrete was first run into the bottom of the cylinder with a tremie made of a piece of 6-in. galvanized iron pipe, handled by block-and-tackle. A diver leveled off the concrete thus deposited, and 24 hours later the cylinder was unwatered and the remaining concrete was placed in the dry.

Canal Zone Water-Purification Plants Meet Tropical Conditions

Information on the treatment of water-supplies in tropical countries is so scanty as to make of great interest the large amount of detailed information on the three water-purification plants in the Canal Zone contained in the annual report of the Governor of the Panama Canal for the fiscal year ended June 30, 1916. The 66 closely printed pages on this subject were prepared by George C. Bunker, physiologist, and form a portion of the report of D. E. Wright, municipal engineer. Some leading facts from Mr. Bunker's extended discussion of the water-purification plants and their operation are given in the following paragraphs.[1]

All three of these water-purification plants employ mechanical filtration, and the two larger ones use chlorination in addition.

The Agua Clara plant, supplying Gatun (population about 1900) was put in operation Dec. 29, 1911. During the year covered by the report it treated an average of 693,300 gallons.

The low alkalinity, 14 to 20 parts per million, of the raw water-supply of this plant—derived from an impounding reservoir—and the amount of alum necessary for the removal of the color, which varied from 30 to 110 parts per million during the year, produced conditions such that it was considered not only advisable, but obligatory, to increase the alkalinity and decrease the free carbonic acid in the filtered water by the addition of lime.

The effect of filtered water with varying free carbonic acid and alkalinity contents on galvanized-iron pipe conveying filtered water to the laboratory of the Agua Clara plant is shown in the two tables given in the report. It appears, says the report, "that comparatively large amounts of iron are taken up by this water while standing in the pipe for 14 hours."

The Mt. Hope purification plant was put in operation Feb. 23, 1914. During the year it treated an average of 4,156,700 gal. for the supply of a population of 37,000 located in Colon, Cristobal, Mt. Hope and Margarita Point, at the northern end of the zone.

A feature of the Mt. Hope plant is an aëration basin 60x66 ft. in plan, equipped with 85 cone nozzles, arranged in five batteries of 17 each. Quoting from the report:

> **The nozzles are so adjusted that, under ordinary operating conditions, the raw water is discharged at an angle of 30° in a thin sheet which breaks up into fine drops. The average diameter of the circle which would be formed by the discharge of one nozzle striking the floor would be 24 ft. The average loss of head due to the nozzle itself is 1.95 ft.**

A typical illustration of the effect of aëration through the nozzles adjusted as just described shows dissolved oxygen increased from 5.09 to 7.38 parts per million and in percentage of saturation from 65.2 to 93.1. The corresponding carbon dioxide was 2.5 parts per million for the raw water and 0 for the aërated water. Detailed figures for the effect of aëration at the Mt. Hope plant are given in the report and likewise for the results obtained at the Miraflores purification plant by aëration through 105 cone nozzles discharging water at an angle of 20° as contrasted with 30° in the case of the nozzles at the Mt. Hope plant.

[1]Those who wish full details will find them in Appendix A, Report of Engineer of Maintenance, Municipal Division, pp. 120-184, Annual Report, Governor of the Panama Canal, Balboa Heights, Canal Zone.

The Miraflores purification plant has been in operation since Mar. 14, 1915. On the average it treated 8,180,000 gal. per day during the year for the supply of 75,000 people in Paraiso, Pedro Miguel, Corozal, Balboa, Balboa Heights, Ancon, Fort Grant and the City of Panama, with a combined population of about 75,000.

During the first 15 months of operation it was found unnecessary to make any repairs or changes to the underdrainage systems of the filters (designed by George M. Wells), which consist of concrete false bottoms 1 ft. thick over pressure chambers 2 ft. deep. In the false bottom there are vertical ⅜-in. feed pipes, spaced 6 in. c. to c. Above the floor the ends of the pipes are bent 180°, so that the wash water is deflected downward. Pressure chambers of filters equipped with and without strainers were examined, and it was found that no sand had passed down through the feed pipes. Mr. Bunker is of the opinion that strainers are unnecessary with underdrainage systems of this type.

Sterilization of the filtered water was continuous throughout the year, hypochlorite of lime having been obtained from the United States in 100-lb. drums and stored in a dry room prior to use. From 0.55 to 0.83 part per million available chlorine was applied.

Twenty days after the disinfection was begun at this plant the discharge pipe from the hypochlorite-solution pump was so badly coated with calcium carbonate as to prevent delivery at the normal volume of solution. During the year it was necessary to clean the pumps and discharge lines about every 10 days, the pumps being in duplicate.

On account of the rapid accumulation of scale in the small centrifugal pumps and their discharge lines and the increased cost of bleach it was decided to substitute one of Wallace & Tiernan's automatic chlorinators, but it was not received until after the close of the fiscal year.

The various water-supplies are from impounding reservoirs, four of these with discharge capacities ranging from 280,000,000 to 650,000,000 gal. when full. The watersheds are uninhabited.

Unusual precautions are taken to prevent contamination by maintenance gangs in the drainage area of the water-supply. These gangs are provided with buckets in which all their dejecta are placed. The buckets are brought in at the close of the day and their contents buried or emptied in vaults outside the drainage areas.

Many wild animals roam over the water-supply catchment areas. Of one of these the report contains the following interesting statement:

> **The one animal which probably adds the largest amount of fecal matter to the water is the tapir, which deposits its excreta directly into the water. During the dry season it hunts out the small streams or feeders which, while nearly dry, have small pools of water into which the animal, weighing from 700 to 1000 lb., continues to defecate from time to time, until a pool is filled up, after which it moves to another. The droppings resemble those of the horse. At the end of the dry season there is a large amount of tapir manure in the beds of all the creeks or feeders, which is carried into the reservoirs by the first hard rain of the wet season.**

The members of the staff of the Physiologist, George B. Bunker, are: Edward J. Tucker, chief assistant and superintendent of the Miraflores plant; Harry T. Campion and Theodore R. Kendall, superintendents of the Mt. Hope and Agua Clara plants; Hugo F. Schmidt, chemist; and Harold W. Nightingale, biologist.

Sector Gates at Middle Falls Dam on Genesee River at Rochester

SYNOPSIS—Description of the movable sector gates on the new hydro-electric development of the Rochester Railway and Light Co., at Rochester, N. Y.

As a part of the new hydro-electric development on the Genesee River at Rochester, N. Y., described in *Engineering News*, Nov. 2, 1916, p. 821, the Rochester Railway and Light Co. is installing as a part of the movable dam at Middle Falls two sector gates, each 100 ft. long. These gates are described by E. R. Crofts, designing engineer of the company, in the January issue of the company's organ, *Gas and Electric News*. From that article the following description has been abstracted, but the originals of the views and drawings have been furnished by Mr. Crofts.

The two gates are identically alike and are separated by large concrete piers, so that each gate is a complete working unit. The movable portion is in the form of a 44° sector of a cylinder 60 ft. in diameter and is built up of steel framework, as shown in Fig. 1. In all there are 13 trusses equally spaced. One radius of this sector is covered by what is called a deck plate, and the front or curved portion is covered by a face plate. The whole structure is hinged at what would be the center of the cylinder, thus allowing the gate to move up and down through the required arc. Angle-irons have been placed on the deck plate to act as skids for the ice and débris passing over the dam. The front and deck plates are ½ in. thick and are made water-tight by calking at the joints.

The whole structure was designed strong enough to support the weight of a 14-ft. depth of water passing over the dam when the gate is in the down position with no water in the chamber underneath to act as a counterbalance or support. Great care has been taken to have

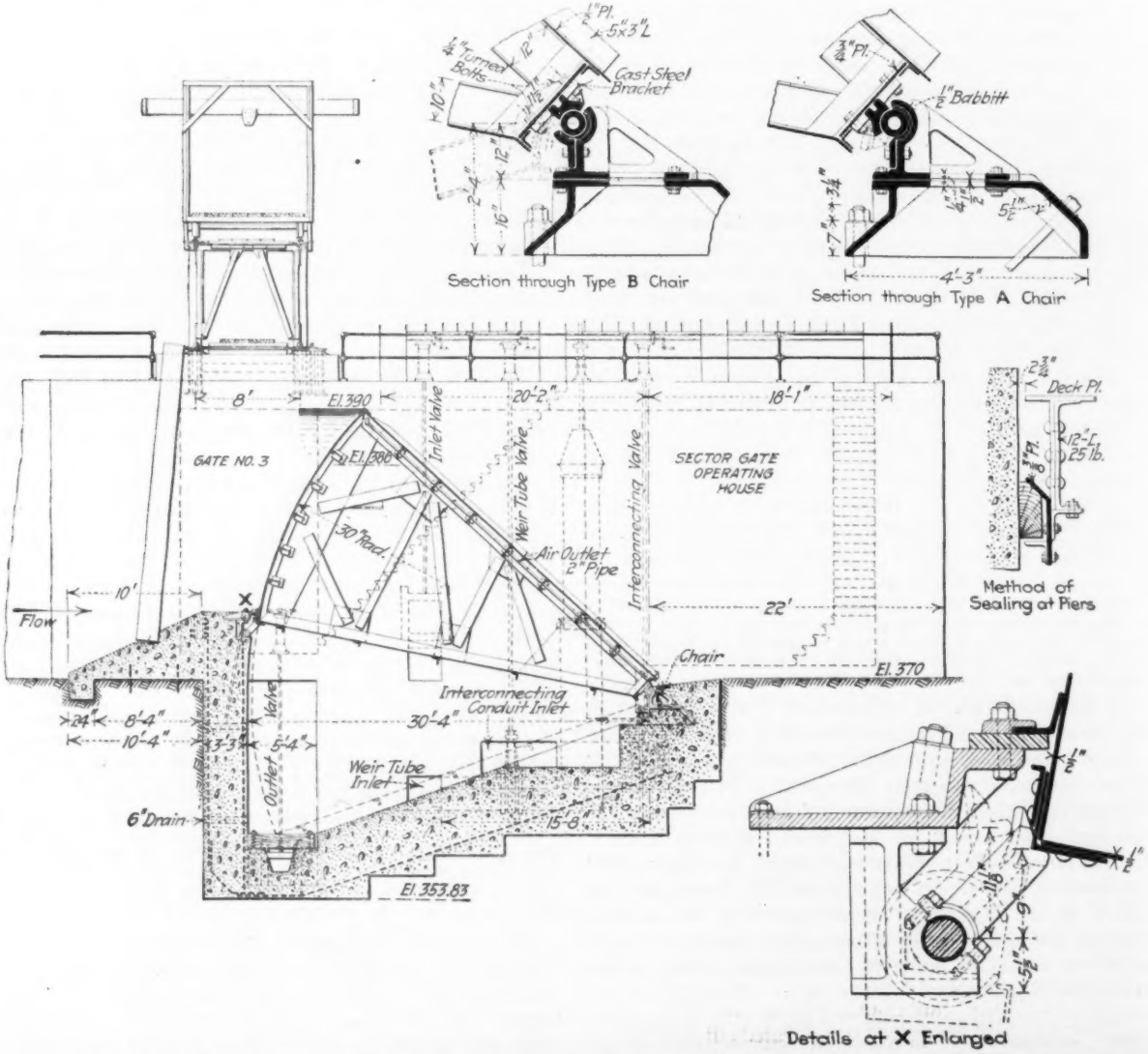


FIG. 1. DETAILS OF 100-FT. LONG SECTOR GATE AT MIDDLE DAM. GENESEE RIVER, ROCHESTER, N. Y.

the front plate a true cylindrical surface, and to this end the whole structure was assembled in the shop and carefully fitted prior to shipment.

The gates are raised and lowered by varying the height of the water in the chamber under the dam. Water is admitted to the chamber beneath the gate from an intake located as far upstream as it was practicable to place it, in order to obtain a maximum head. When the gate is in the down position, there is a difference of elevation of 6½ ft. between its peak in front and the top of the deck plate at the hinge. This head of water will cause an upward pressure on the deck plate sufficient to lift the gate very slightly off the sills at the bottom of the chamber and, if the water in the pond is held at the same elevation, place the gate in equilibrium. In this position two forces are acting on the gate—namely, the weight of the structure, and the upward pressure of the water. As the gate rises, the center of gravity of the gate moves through an arc, so that its horizontal distance from the center of the hinge steadily decreases.

If, therefore, the water in the pond is allowed to rise with the peak of the sector, the gate will continue to lift to its up position, due to the steadily decreasing moment of the weight of the structure about the hinge and the increasing pressure of the water on the under side of the deck plate. It would be possible, therefore, to raise the gate with a full flood passing over it, if it were necessary to do so. In order to adjust the height of the gate, it is necessary to adjust the elevation of the water under the gate; that is, if the gate is to be held in a certain position, it is necessary to keep the elevation of the water inside constant. This is done by means of a special valve called a weir tube, a detailed description of which appears later in this article.

The water used in operating the gate passes first through a coarse screen at the entrance and then through a fine screen placed in a separate chamber. Behind this fine screen are two 30x30-in. sluice gates, each of which controls the flow to a gate, through which the water passes to a large settling chamber where it is hoped most of the silt will be deposited. Another 30x30-in. sluice gate controls the flow from this chamber to the chamber of the dam. In order to remove the accumulated silt a 24x24-in. sluice gate was installed at the lower end of the chamber to allow sluicing of the silt deposits into the tunnel below. In order to catch any silt deposits that may pass through the settling chamber and also to insure complete drainage of the chamber when necessary, a small ditch was placed in the bottom of each chamber. The water from the gate chamber is drained off through a 24x24-in. sluice gate out into a small tunnel placed exactly on the center line of the operating pier. The overflow from the weir tube is also carried off through this tunnel.

Design of the Gate Hinge

It is absolutely necessary that free air conditions exist in the peak of the dam; to insure this, twenty-four 2-in. air pipes have been carried into the peak space from the space from behind the hinge. As the water rushes over the gate during flood period, it will evidently tend to suck the air out through these pipes from within the dam, thus creating a partial vacuum and putting an excessive load on the structure. In order to prevent this condition large pipes have been installed to connect the space back of the hinge directly with the outside air.

The hinge is 100 ft. long and continuous. Several ideas were developed, but the one shown in detail in Fig. 1 seemed to adapt itself best to the work required. The shaft is made of cast steel 6 in. in diameter, and is hollow in order that a steam pipe may be run through the shaft and returned inside the dam, so that the formation of ice near the hinge can be prevented. Should a large amount of ice collect close to the hinge, it is evident that the nut-cracker action would be fatal to some part of the structure.

It was essential that the shaft should turn with the moving parts, in order that an indicating device could be put on the end in the operating house so that the operator might know the exact position of the dam at any time during the flood period. The thrust of the gate is carried to a heavy girder of structural steel, well braced to the deck plate and to the lower lateral system of the trusses. To this girder, located 6 in. away from the center line of the sector, cast-steel shaft brackets have been fastened. The 6-in. cast-steel hollow shaft was bolted to these shaft brackets by means of tap bolts, and the brackets were in turn fastened to the structural-steel girder by means of 1¼-in. turned bolts.

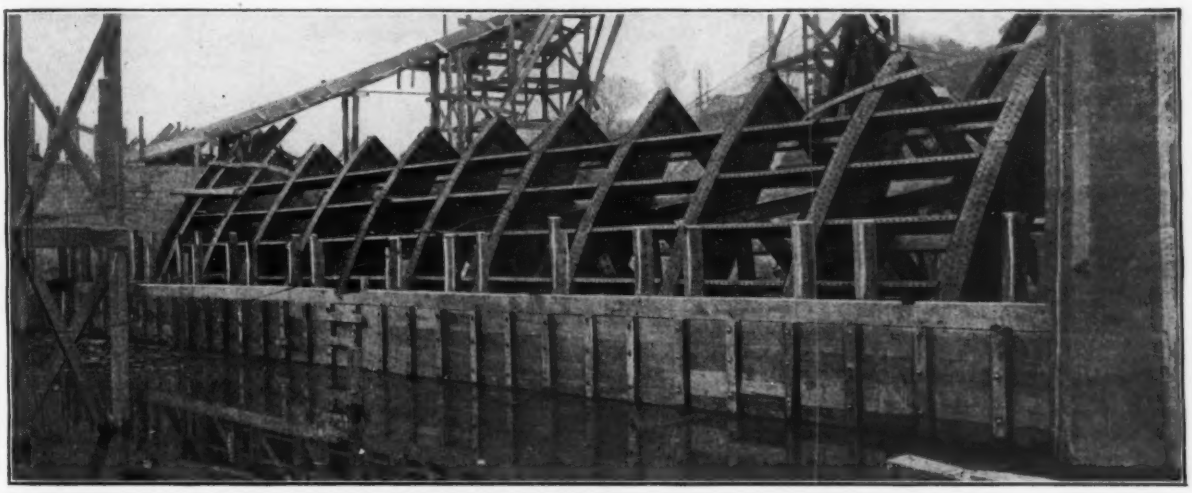


FIG. 2. VIEW OF FRONT OF GATE UNDER CONSTRUCTION

The greatest stress that comes on the hinge is not the thrust from the water in the pond, but the lifting force due to the water under the deck. This will also explain why the castings carrying the shaft were built in the form of a hook. It was impracticable to design shaft brackets that would make the lines continuous, so two types of bearings were designed—one called Type A and the other Type B, the former taking practically all the "uplift," assisted when the dam nears the up position by Type B, which has fastened to it the cast-steel keeper that takes all the downward reaction when the floods are passing over the gate.

The cast-steel bearings are all bolted to heavy cast-iron bed plates, which in turn are anchored with heavy bolts into the concrete. The anchor bolts do not grip sufficient concrete to withstand the uplift, so a heavy reinforcement was put in the entire floor of the chamber to tie together the whole mass of concrete contained in the chamber.

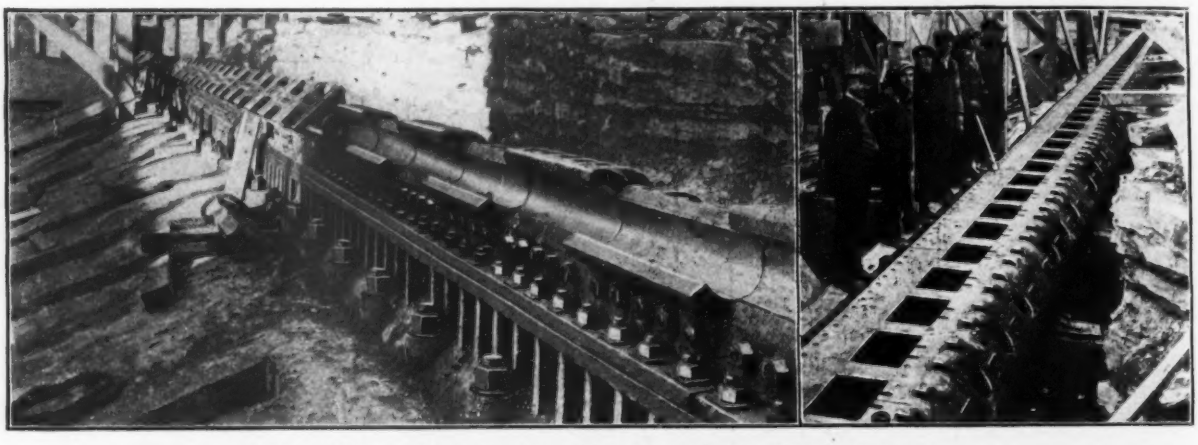
The hinge was designed so that a perfect alignment of all the parts could be obtained in the field as easily as possible. For this purpose the tops of the cast-iron bed plates were machined, and the bolt holes were carefully checked after the bed plates were lined up in position. The cast-steel bearings were carefully machined to the same jig, and all were babbitted with a mandrel in exactly the same position, so that the center line of the shaft had to be exactly the same distance above the bottom of the casting at every point. Each keeper was placed on its respective casting, babbitted in that position and shipped to the field bolted to its particular chair. The tendency for these bearings to shift downstream was taken care of by the lugs on the cast-iron bed plates, which proved to be a very handy place for the fieldmen to work from in the erection of the hinge. A high-grade babbitt was chosen for the bearings, because the pressures will run fairly high.

A very low unit stress was used both in the iron and the steel castings. This was done, not because it was considered impracticable to get good castings, but because of the fact that the gate might be subject to a shock of undeterminable amount, such as that from a large tree coming down the river or a large field of ice suddenly loosened; and all the shocks received by the structural-steel work must be taken care of by the hinge. A very good grade of steel castings was secured for this work; the steel is very ductile, and there appears to be no danger of wrecking the hinge by a sudden shock.

Weir Tubes Control Gate Weight

The weir tube is a special valve for controlling the level of the water in the chamber under the gate. It consists simply of a cast-iron pipe 36 in. in diameter, set in a pit in the operating pier. At the top of this pipe is a stuffing-box through which a 30-in. pipe, turned on the outside, slides. At the top of this 30-in. pipe is a heavy cast-iron outfall to which a 4-in. shaft for raising or lowering the tube is fastened. Cables, which pass over sheaves to a concrete counterweight in a separate chamber, also fasten to this head casting. The 4-in. shaft connected to the head casting passes up through a floor stand placed on the floor of the operating house and is threaded for a length of 10 ft., that being the range of movement of the tube.

The floor stand is motor operated, so that the tube may be controlled from a distance if desired. Each gate has its own tube, and should either tube become jammed or damaged, it may be segregated by closing a 30-in. gate valve interposed between it and the dam chamber. One conduit in which there is a 24-in. gate valve connects both chambers; and when one tube is out of commission, the valve may be opened and both gates may be controlled by one tube, if it is so desired.



FIGS. 3 AND 4. HINGE TO SECTION GATE ON GENESEE RIVER DAM

Fig. 3 (Left)—Shows hinge partly assembled, looking toward operating pier. Note shaft brackets attached to hollow shaft ready to receive structural work. Hook castings are Type A, low castings are Type B. Fig. 4 (Right)—Shows cast-iron bed plates ready to receive the cast-steel bearings

The hinge for one sector dam contains 25 tons of iron castings, 30 tons of steel castings, 2500 lb. of high-grade babbitt metal and about 1½ tons of 1¼-in. diameter bolts. The hinge was furnished by the Ricker Manufacturing Co., of Rochester, N. Y. The structural steel of each gate weighs 150 tons and was furnished by the Chicago Bridge and Iron Works, Chicago, Ill. There are about 18,000 field rivets to be driven in each gate. The breast wall plates, prop and prop shaft for one gate weigh 45 tons and were furnished by Jackson & Church Co., of Saginaw, Mich.

The project has been carried on under the supervision of the Engineering Department of the Rochester Railway and Light Co. J. T. Hutchings is General Manager, and F. J. Howes is Chief Engineer, with Mr. Crofts in charge of the work at the dam. N. H. Guinter was resident engineer for the whole project. The Dock Contractor Co., of Hoboken, N. J., is the contractor.

Engineers' Fees in Iowa

A schedule of minimum charges for engineering services was recently adopted by the Iowa Engineering Society, the substance being as below:

Engineers as a rule now base their charges upon one of the three following methods: A per diem rate; a fixed sum; or a percentage of the cost of the work. In the following proposed schedule, based upon the above methods, current practice has been combined with ideas put forward by members of similar state organizations in an effort to supply a basis upon which fees for the professional services of the engineer may be standardized at some future time.

PER DIEM RATE—(1) Consultations, opinions, expert testimony, preliminary investigations and preliminary reports, $25 per day. (2) In a consulting capacity on design or for services covering a greater period than one day, $25 per day. (3) For examinations or reports of a more extensive nature, $15 per day.

While absent from home city, or attending court or similar duties or traveling, each day of 24 hr. or fraction thereof shall be considered as one day, irrespective of the actual time spent on the case. Otherwise, seven hours shall constitute one day. An additional charge shall be made to cover actual expense and expense of assistants.

FIXED SUM—(1) A fixed sum covering all services and expenses may be charged. (2) A fixed sum covering services only may be charged, and additional charge made to cover expenses both personal and for assistants. A fixed sum may be charged for any well-defined portion of work on a project, and the balance may be charged per diem or by percentage of the cost of the proposed work.

PERCENTAGE OF COST—(1) For services of a preliminary nature, estimates, reports, etc., 1½% of the cost. This can be handled on a per diem basis or on a fixed-sum basis. (2) For the above services and in addition the preparation of the drawings, specifications and contract, and all work to the letting of the contract, 2½% of the cost. (3) For services included in (2) and handling the letting of the contract and consulting supervision of the work, 5%. (4) For services included in (3) and full responsibility for the inspection and construction, including all engineering, 6% of the cost.

In making a contract for services, either on the percentage plan or the fixed sum, a time limit should be set, and the engineer should fix a proportional additional charge for extension of time of completion in case it is in no way his fault.

In Iowa a large number of engineers are engaged in both drainage and municipal-improvement work. The charges for the former do not cover private drainage work, but only drainage-district work where the cost reaches $20,000. Consultation and expert testimony, minimum charge per day, $25 and expenses. Field engineer, minimum charge per day, $10, adding cost of help and all expense. Municipal engineering is best handled on a percentage basis in most cases, and the minimum fees suggested are: 6% for water-works and lighting plants, 5% for paving and 7% for sewers. Both of the two latter are exclusive of inspection fees, but include assessment plat and schedule.

Curved Concrete Abutment Patented

Under date of Sept. 26, 1916, the United States Patent Office granted a patent to Milton T. Thompson, of Keokuk, Iowa, on a curved reinforced-concrete abutment designed according to the drawings shown in the accompanying facsimile of the patent and specification drawings. The wall, it will be noticed, is in plan a semicircle with extending tangential legs. It is built of concrete reinforced with circumferential rods, spaced and arranged vertically to accord with the sloping sides of the abutment, as shown in Fig. 3 of the specification.

The principle of the wall, according to the specifications, is that buried rear wings are held by friction sufficient to create a tangential reaction at the end of the wall. The thrust of the earth back of the wall is transmitted from the earth radially to the wall and thence circumferentially back to this frictional reaction. It is claimed that with this principle the wall can be designed much lighter than for any other type of wall.

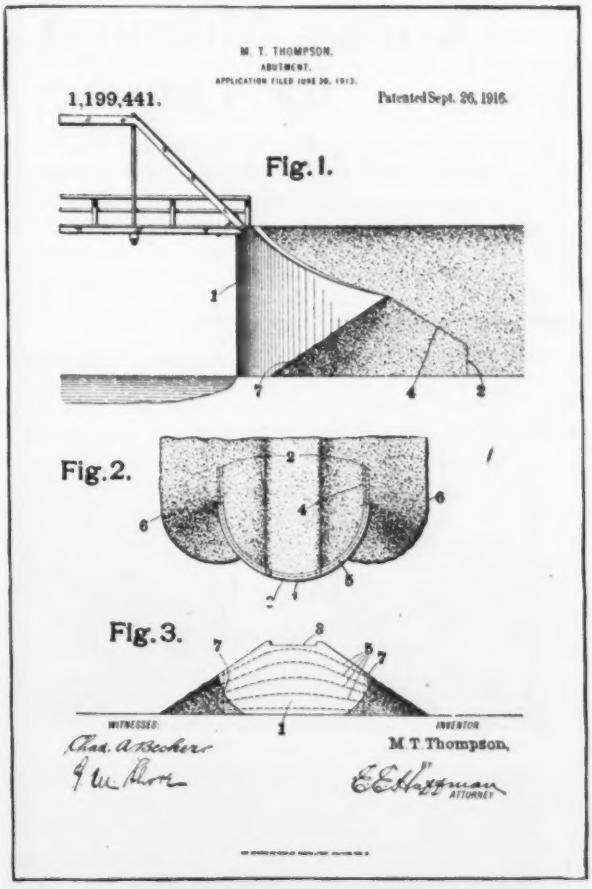


FIG. 1. FACSIMILE OF PATENT SPECIFICATION DRAWING ON THE CURVED ABUTMENT WALL

Several such walls have been built in connection with the roadwork around the Keokuk dam across the Mississippi River. One of these is shown in Fig. 2. The

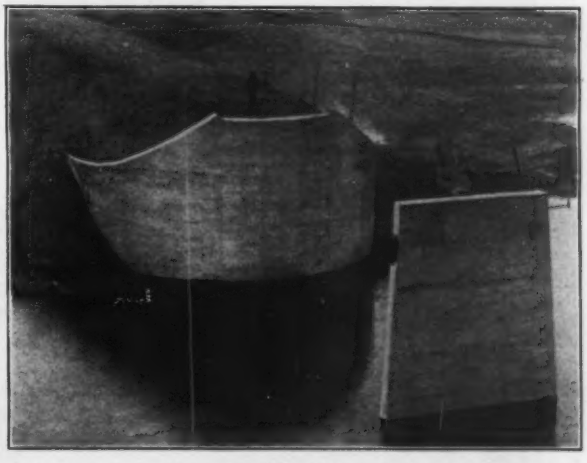


FIG. 2. CURVED ABUTMENT FOR BRIDGE NEAR KEOKUK

abutment is 28 ft. high above the foundation and has a uniform thickness of 15 in. from top to bottom.

The rights to use the patent are controlled by the Thompson Abutment Sales Co., 120 W. 32nd St., New York City.

Quarter Million Yard Excavation Made for One St. Louis Building

The growing prohibition wave has reacted in at least one instance to the benefit of engineers and contractors. In St. Louis the Anheuser-Busch Brewing Association has now under construction a $4,000,000 plant for the brewing of its new non-alcoholic beer, known as Bevo. This product was put on the market only about six months ago and so soon proved successful that the advertising campaign had to be curtailed, pending the construction of a new plant, which was immediately ordered by the Association when it was found that the beverage would prove so popular. Every effort is being made to put the new plant into early service.

FIGS. 1 TO 5. PROGRESS VIEWS OF EXCAVATION FOR BEVO BUILDING AT ST. LOUIS AND (BELOW) ARCHITECT'S PERSPECTIVE OF BUILDING

The site for the new structure was selected just east of the large area now occupied by the brewing plant, and plans were immediately made for the construction of a reinforced-concrete building 252 x 600 ft. in plan and eight stories above ground in height.

This plan is shown in the architect's perspective in Fig. 5. It occupies a whole city block on a site which had been up to that time used as the entrance for the street-railway tracks approaching the main brewing plant. The new construction required the excavation of the site to a maximum depth of 30 ft., the transfer of the railroad tracks to a yard nearer the river, which is only a few blocks east of the site, the reduction in grade of the blocks east of the site to permit the entrance of trains under a viaduct carrying the street in front of the plant. The whole excavation, the construction of the viaduct (which will become city property) and the construction of the plant were not started until late last fall. Fig. 1 shows the site on Sept. 2. The succeeding

FIG. 6. CARS DUMPING TO MAKE FILL ALONGSIDE MISSISSIPPI RIVER

views show the very rapid progress made in the excavation, which, when completed, will total 250,000 cu.yd.

At first bids were considered for the excavation, but it was afterward decided to do the work under the direction of the Manufacturers R.R., a terminal railroad controlled by the Anheuser-Busch company. This organization, under the direction of William Cotter, President, and R. P. Dalton, Superintendent, carried out within four months practically the whole of this quarter-million yard excavation by means of large and small steam shovels, dumping into large-capacity dump-cars that traveled on the main-line tracks of the Manufacturers R.R. to a dump on the near-by river front, where a new terminal yard was made with the fill (Fig. 6).

During the excavation the street in front of the building which in the future will be on a reinforced-concrete viaduct, is carried on a timber temporary structure, a part of which is shown in the foreground of the view taken Jan. 15, 1917. On this temporary structure run street car tracks, a highway and sidewalks. Underneath it the earth excavation trains pass to and from the site and the tracks carrying material trains for the building construction are located.

At one time four steam shovels, one clamshell working on a derrick and one locomotive crane were in operation on the site. The progress pictures show the method in which the excavation was made. Two steam shovels, one a 70-ton Marion and one a 70-ton Bucyrus, were in operation practically all the time; and two smaller shovels, one a 14-B Bucyrus and one an 18-B Bucyrus, were used in the corner work, where the smaller shovels could not reach. With this equipment very high yardage records were made. The excavation for the most part was in earth, although there was some rock as grade was reached. All the excavation, however, was made with the steam shovel. In one 10-hr. day 5700 cu.yd. was dug with the two large shovels, which were equipped with 5-yd. buckets. The loading was made on trains of 12- and 15-yd., Western Wheel Scraper Co., steel cars, which had been brought up from the Panama Canal, where they had been in service during practically all the construction. They were found to be in remarkably good condition and served admirably for the purpose.

The total cost of the work has been very low, considering the speed with which it has been done and the nature of the work. Bids ranged as high as 80c. to $1 a cubic yard for excavation, but with about 5000 yd. yet to go, it has been found that the average cost per cubic yard will be about 45c. Fig. 4, taken on Jan. 15, shows the excavation practically completed and the north end of the reinforced-concrete building under construction. This building is to be very heavy, having a live-loading of 250 lb. per sq.ft. on all floors. It is of beam and girder reinforced-concrete construction, to be built in sections 252 ft. long and about 125 ft. wide, divided by expansion joints through all the stories.

*

California Greatest Manganese Ore Producer in 1916—For the first time in the history of manganese mining in the United States, a Western state, removed from the steel-producing centers, took the lead in 1916 in the production of manganese ore. According to a preliminary estimate of the United States Geological Survey the biggest producers were California, Arkansas, Arizona, Georgia, Virginia, Utah and Colorado, the aggregate output being 27,000 tons—the greatest since 1888 and nearly three times that in 1915. The estimate does not include manganiferous ores that contain less than 40% manganese. Imports of manganese ore for the first 10 months of 1916 amounted to 495,299 tons, of which 401,177 tons came from Brazil.

Congress Is Nearly 0.5% Engineer—The desirability of the engineer's participation in public affairs has been urged repeatedly, until there is danger of its becoming a monotonous refrain. The concrete result of this agitation—so far as the national legislature is concerned—appears to be a grand total of two engineer Congressmen. The New York "Evening Mail" recently made a professional inventory of the members of Congress, with the following results:

Of our 96 United States Senators the classification is as follows: Lawyers, 53; farmers, 5; editor, 1; cotton planter, 1; planters, 2; stock raiser, 1; bankers, 2; literature, 1; journalists, 4; public officials, 22; physician, 1; irrigationist, 1; lumberman, 1; manufacturer, 1.

Of our 440 Representatives there are these classifications: Lawyers, 240; public officials, 79; bankers, 15; editors, 6; physicians, 2; farmers, 19; manufacturers, 11; merchants, 3; real estate, 10; lumber, 3; publishers, 10; stock raisers, 2; journalists, 3; steamboat, 1; towing, 1; contractors, 3; cattle, 1; agriculturist, 1; iron molder, 1; insurance, 1; engineers, 2; director, 1; landholder, 1; hotel, 2; educators, 5; ranchmen, 4; city assessor, 1; nurserymen, 1; coal miners, 2; chemist, 1; wool merchant, 1; writer, 1; cotton, 1; ruggist, 1; railroad official, 1; mercantile, 1; telegrapher, 1; capitalist, 1.

If the list quoted is accurate—and the two engineers are not of locomotive or stationary class—the engineer faction is not likely to exert vast influence in placing laws on the national statute book. The lawyer has always been dominant in politics. In the present Congress he is, numerically, 55% of the Senate and 55% of the House. The engineer is not quite 0.5% of the total—a humiliating condition. Much the same condition obtains in the House of Commons. The London "Times" contends that the present elective system is misrepresentative, and it favors election by occupations, industries, trades, rather than by geographical divisions or community

Bucking the Big Drifts in Wyoming

By J. Cecil Alter*

SYNOPSIS—Fighting the greatest snow drifts on record on the Union Pacific R.R.

No less than 40 transcontinental passenger trains were snowbound and idle in Wyoming between Laramie and Rawlins at one time during the snow blockade of January-February, 1917. The Union Pacific System, concentrating its attention on the 46 miles of line between the Lookout and Hanna stations, waged what is considered to be the most important fight in its history against wind and snow—a battle that did not cease night or day for two weeks.

From Jan. 22 until Feb. 4, the double- and triple-track roadway was sealed in by deep, hard snow for the first time in history. When the army of snow-fighters "holed through" for the last time, the wind blew a practically continuous gale from the west, filling the cuts with snow sometimes within half an hour after opening them by the rotary snowplows. Within this period trains were forced through the blockaded region with the greatest difficulty, and delays of from 6 to 36 hours were common. Freight movement was entirely suspended; and from Jan. 25 to 27 and from Feb. 1 to 3, when the wind seemed at its height, no trains penetrated entirely through the blockade.

Beginning, however, on the night of Feb. 4, the wind subsided and trains began to move. In this movement new records for train handling are said to have been established. There was a congestion of between 40 and 45 passenger trains, many of which were stalled between stations. Practically all had to be dug out by the work of approximately a thousand laborers with picks and shovels. The tracks were entirely cleared in both directions in the 24 hours of Feb. 5. Then followed the movement of freight, which, until date (Feb. 18), has been flowing in each direction from the continental divide in streams of from 90 to 95 trains, of from 20 to 25 cars each, per day. Added to these were 16 daily passenger trains and the exchange movement of freight helper engines between Cheyenne and Laramie over Sherman hill. The 10-min. limit between movements has often been approached for many hours at a time in spite of the full use of the double track.

A general snowfall covered the Laramie and Rawlins plains, through which the railroad trends longitudinally, the depth varying on account of the wind from practically nothing to a foot, until Jan. 22. From Jan. 12 to 22, exceptionally cold weather prevailed, temperatures ranging as low at 26° below zero at the Rock River coöperative weather station. The continued cold has the effect of producing minute ice particles of the snow crystals under constant motion from wind agitation.

A fall of 6 in. of snow occurred at Rock River on Jan. 22 in comparatively low temperatures, and with it came the gale. A week later about 2½ in. more snow fell. No wind record is available in the snowbound region, though the opinion of employees and local residents is that velocities were unusually high and persistent. Substantiating this, to a certain extent, is the wind record at the United States Weather Bureau Office at Cheyenne, which shows the greatest continuous-velocity records since 1871. From Jan. 21 to Feb. 4, 1917, the average daily wind velocities ranged from 14 to 39 miles per hour, and the maximum wind velocities from 41 to 64 miles per hour.

FIG. 1. ORDINARY STEAM-DRIVEN ROTARY, PUSHED BY THREE LOCOMOTIVES

*Cheyenne, Wyo.

MIG. 2. REAR OF SNOWPLOW TRAIN IN SULPHUR LAKE CUT

The contention seems reasonable that the wind blowing across the so-called Great Divide Basin, in south-central Wyoming, is forced through a relatively narrow neck between the Medicine Bow Mountains and a range to the north, and the velocities, under such favorable conditions as just experienced, become abnormally high. In any event this narrowing of the plains causes a definite broadside discharge of wind across the Union Pacific tracks from Lookout to Medicine Bow, where the trend of the line is northwest-southeast.

Only four or five cuts of any great length in this comparatively even-surfaced plain are necessary to maintain the desired grades, and these are broad and shallow as a rule. Two of these, at Lookout and Rock River, have filled at times in the past, notably when the wind and snow were accompanied by intense cold. The two cuts at Sulphur Lake, of a half-mile length, and a 1¼ stretch near Wilcox are said never before to have required any important service from the rotaries. These cuts have a more westerly trend, parallel with the prevailing winds.

FIG. 3. JORDAN SPREADER CLEARING SIDINGS AND SWITCHES AT ROCK RIVER

At Lookout a cut about 900 ft. long was opened frequently; at Rock River the entire yard limits of about ¾ mile were opened on both tracks with rotaries. Some of the space was opened a number of times. At Wilcox a total of about 1½ miles of cut was filled with snow from 6 to 12 ft. deep, requiring the opening of both eastbound and westbound tracks with the rotaries twice, and in places many more times. The Sulphur Lake cut, near Allen, a half-mile in length, was filled as deep as 20 ft. in places and required drilling with the rotaries four times, with numerous extra trips for cleaning before the storm ceased. In all the deeper cuts extra trips were necessary with the rotaries before the trains could pass over the rails in safety.

In many of the drifts the depth was greater than the capacity of the rotaries and short holes were drilled, into which the sides and top were broken by laborers—a slow, tedious process. In regions where desert sand was mixed in large proportions with the drifted snow the deposit was so compact that only the huge Jull steam-propelled rotary snow excavator, having a large steel corkscrew projecting from the center of the rotary, could attack it successfully, and then only when three of the largest locomotives available were pushing it against the snow.

Four other steam-driven rotaries were busy every hour for 15 days, a commissary car being attached to the rear for the workmen. In addition there were two Fuller, or wedge, plows built on box cars; two Russell plows, similar to the Fuller plows, but larger; six locomotives having wedge snowplows attached in front; and eight engines equipped with circle flangers, or disks for throwing the snow from the rails only. This was practically all the equipment that could operate in the limited territory affected, though a large-winged Jordan spreader was employed in clearing sidings and switches ahead of the laborers. A steam shovel and dynamite were given a trial with but little success. The shovel was too slow for work in such high wind velocities, and the explosions were too local and limited in effect to loosen much snow.

Snow fences of the common kind, which in the past have performed effective service, were early drifted under, though from four to seven lines were placed about 75 ft. apart. Subsequently, numerous additional lines of fence

FIG. 4. LOOKING NORTH AT ROCK RIVER STATION; NOW UNDER STEEL SNOWSHED

were placed on the drifts; but as the wind did not cease, these too were soon under the snow or so much obstructed as to be of little value.

For the future, defense by snow fences is being improved in every possible manner, to deflect and accumulate snow in the most desirable places; and a large part of the main yards at Rock River, about 600 ft. each way from the coal chute where drifting was very heavy, is being covered with a steel snowshed. The inclosure protects the eastbound and westbound tracks and the passing track between. This work is already practically completed.

The damage to track and equipment, aside from wear and tear, was practically negligible, in spite of the frequent deaths of a great many engines stalled out of reach of water or coal. One fatal accident occurred, when, in the blinding snow, a young employee on a private errand stepped from a caboose in front of an approaching train. No other injuries of any kind were reported, and not a

passenger suffered any special hardship or physical inconvenience, as food, heat and bedding were provided just as in ordinary travel, but without expense to any one. Even special entertainment was offered by citizens of Cheyenne, Laramie, Rock River and Rawlins; and for some travelers the joys of jack-rabbit hunting were too abruptly terminated by the clearing of the lines.

Light Timber Auditorium Roof Fails Under Snow Load

By Edwin K. Cortright*

Failure of the lower chord of a 30-ft. roof truss (Fig. 1), due to a heavy snow load during construction, caused the partial collapse of the roof of a wooden temporary meeting shed at Lawrence, Mass. The building, approximately 132 x 240 ft. in plan, has been repaired and will be used as originally intended.

A heavy snowfall combined with snow blown from the roof of a near-by office building caused the initial failure of a roof truss. As no other ties between columns had been provided, the side thrust induced through this failure pushed the remaining portions of the building about 2 ft. out of plumb and allowed the adjoining roof trusses to slip from their bearings. The failure began at the north end of the building and progressed toward the south end, the entire collapse extending over an area 30 x 240 ft. and occupying an appreciable space of time. Had some sort of transverse ties been provided originally between the supporting columns, the failure, in all probability, would have been confined to one or two roof trusses.

As shown in Fig. 2, the original design provided for trusses on 10-ft. centers, half the longitudinal panel length. This truss, with a rise of 4 ft. 8 in., was made up of a 2 x 6-in. upper chord with a butt joint and a 1 x 8-in. lower chord spliced at the middle. Center and inclined 1 x 8-in. posts were used.

Immediately following the failure all snow was cleaned from the roof of the remaining portions of the building and all lumber of value salvaged from the wreckage. The work of pulling the standing portions back into place was then undertaken. The columns were braced transversely near the tops with temporary 6 x 6-in. struts and crossbraced with 2 x 6-in. plank. Wire cables were attached to the 6 x 4-in. posts and the first 6 x 6-in. posts. The center 6 x 6-in. posts were not subjected to any pulling strain. Chain blocks attached with block and tackle to the wire cables were used for the actual pulling. Pulling operations were carried on simultaneously on three adjoining bents, to prevent eccentric stresses. All work of pulling the building back into place was successfully completed in about three days' time.

*40 Lawrence St., Lawrence, Mass.

FIG. 1. THIS SHED COLLAPSED BY FAILURE OF THE LIGHT TRUSSES UNDER DRIFTING SNOW

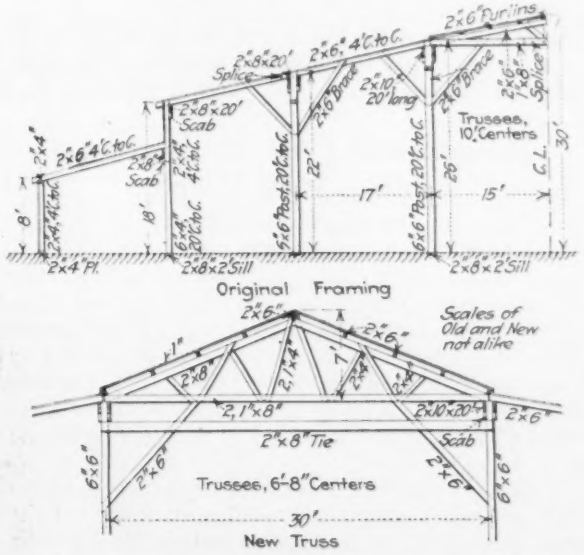


FIG. 2. THE ORIGINAL FRAMING, AND STRONGER TRUSSES USED IN RECONSTRUCTION

New and heavier roof trusses on 6-ft. 8-in. centers, as shown in Fig. 2, have been provided, and a substantial 2 x 8-in. cross-tie has been added as an extra precaution against further accident.

Traffic Census in Shanghai—As an item for the curious, John A. Ely, of St. John's University, Shanghai, China, sends the following results of a traffic census at the corner of Kiengze and Nanking Roads, Shanghai, during the hours 7 a.m. to 7 p.m.; Rickshaws, 20,441; carriages, 1754; motor cars, 1610; street cars, 640; wheelbarrows, 1785; making a total of 26,230 vehicles of various types, and 35,588 pedestrians. Of the vehicles it is interesting to note that 22,226 or 85% were of the one-man power variety—rickshaw and wheelbarrow—which are not very severe on pavements.

Brown Rot in Yellow Pine—Elaborate studies of the physiologic activity of brown rot or "brown punk" in yellow pine were made recently by Sanford M. Zeller at Washington University, St. Louis, Mo. His results have been published recently in pamphlet form by the Missouri Botanical Gardens. The rot is the growth of the fungus "Lenzites saepiaria," which attacks mainly coniferous timber. The brownish or sepia-colored sporophores appear near cracks in the wood due to drying. The fungus is in nature very common on railroad ties, telephone and telegraph poles, etc., but may be found on standing timber. Its growth is strongly promoted by acids (even with 0.25% sulphuric acid it grew luxuriantly) and is inhibited by liquids of alkaline reaction. The growth range of temperature is 5° to 44° C., the best temperature being 35° C. (95° F.). The fungus cannot grow on resin. Experiments made to show how high a resin percentage was required to prevent the growth were made by mixing agar-resin plates. No marked influence of the resin appears until a percentage between 50 and 60 is reached, when there is a sudden reduction of growth, holding up to about 85%, beyond which there is practically no growth. When the fungus was grown on blocks of yellow pine, the influence of resin content of the wood was quite erratic, as is to be reported in detail later. Very full study was made of the enzyme activity or products of the fungus. A large number of enzymes was identified, most of them being highest in the mycelium.

Notes from Field and Office

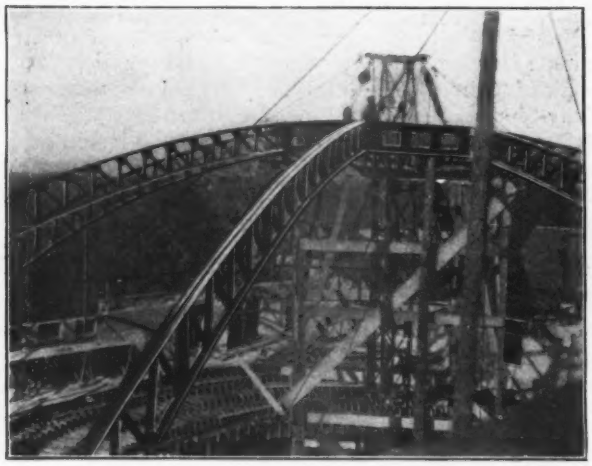
Church dome cost $28 a ton to erect—Plea for commonsense dimensions—Origin and evolution of the steel handbook—Carrying railways over trenches—Plow places signal cable 12 ft. below channel bottom

Method and Cost of Erecting a Large Steel Dome

By M. Van Meter*

The 92-ft. dome of the Wealthy St. Baptist Church, Grand Rapids, Mich., has a steel frame formed by eight main arch members 35 ft. in span, with 19-ft. rise, framing into an octagonal crown diaphragm, 22 ft. wide across the points. The arches are tied together at the heel by four trusses and four sets of angle ties. This is because that portion of the building under the dome is square, and a part of the roof load is carried by the ties in alternate bays.

The arches are 2 ft. deep at the top and 5 ft. at the outer extremity. Three lines of beams parallel to the base ties carry the wooden ceiling and roof joists. The



ERECTING ARCHES OF CHURCH DOME

lateral bracing consists of a system of rods together with a line of struts in the center of each bay at right angles to the roof beams. A steel monitor frame 8 ft. high surmounts the structure.

The erection procedure was as follows: A derrick of the required height was raised, and the eight sides of the diaphragm were riveted up around its base. With two sets of blocks, the ring was raised to the final elevation, 45 ft. above the floor, and light timber falsework placed underneath. The arches were raised with a gin pole, bolted in place, and the base ties erected. The roof beams, struts and rods were then placed, rivets driven and supports removed. The entire job was completed without a mishap, the one anxiety being caused by the extraordinarily high winds that prevailed after the diaphragm was raised and before the timber falsework was finished.

The shop cost of this contract was $25 and the erection cost $28 per ton, with labor at 50c. per hour in each case.

*Chief Engineer, Cadillac Machine Co., Cadillac, Mich.

Eliminate Weird Dimensions

By Henry J. Marty*

Charles M. Horton's article, "Drafting Room vs. Shop," in *Engineering News*, Feb. 1, p. 195, expresses sentiments that draftsmen and mechanics will echo.

Detailers and checkers could save some of their fellow draftsmen a modicum of nerve energy by using sane dimensions. Here is a boiler 22 ft. $8\frac{11}{16}$ in. from the foundation to the face of the steam nozzle; why not make it 22 ft. 9 in.? There is no over-all dimension, from the front or back of the boiler to the steam nozzle. Another instance—a large corliss engine, 17 ft. some inches and a few eighths from the centerline of the shaft to the centerline of the throttle. Corliss-engine builders are not the worst offenders; take the little fellows—6 ft. $4\frac{7}{16}$ in. from centerline of shaft to centerline of throttle; $16\frac{3}{16}$ in. from centerline of shaft to centerline of bolt-hole; the other way it is $21\frac{5}{8}$ in. from centerline of cylinder to centerline of bolt-hole—and so on for eight or more bolts.

Look into almost any catalog of power-transmission machinery: A hanger with four bolts is $20\frac{5}{16}$ in. from the center of the shaft to the center of the two bolts on either side, and the latter are $6\frac{3}{8}$ in. apart; why not 20 in. and $6\frac{1}{2}$ in.? On bevel gears the backing from centerline of shaft to the back of the pinion hub may be $19\frac{21}{32}$ in., and to the back of the gear $7^{27}/_{64}$ in.

It probably has not occurred to some of the manufacturers of small steam pumps that their products might be used in a factory where the foundations are installed months before the pump arrives. The carpenter gazes at the blueprint and wonders whether $6^{21}/_{64}$ in. is nearer $\frac{1}{2}$ or $\frac{1}{4}$ in.

On outline diagrams of centrifugal pumps it is sometimes difficult to determine just what is meant. It is desirable to have the distances from the pulley, suction and discharge openings and bolt-holes given, so that no addition or subtraction will be required. Eliminating fractions in this instance might save a dispute.

The fractions have been taken out of flanged pipe fittings, and the burden can be lightened on other work, such as where boilers, engines and thirty or more pump foundations are detailed, for pipe 6 in. and over made up in the shop, shaft-hanger supports made up of structural steel and provided with holes to take the hanger bolts. This machinery may go to the wilderness a thousand miles from where it was made. When it gets there, time is worth more than money.

*1434 Ridgewood Ave., Cleveland, Ohio.

History of Structural-Steel Handbooks

By R. Fleming*

A number of handbooks of unusual interest lie before the writer.[1] The oldest, undated and unpaged, was published by the Phoenix Iron Co. in 1869 and is believed to be the first handbook issued by a manufacturer explaining in detail the use of iron for structural purposes. The book consists of 24 pages 3¼x5 in., 13 of which are taken up with the title, advertisements and lists of the Phoenix products, seven with tables and formulas; four are headed "Memorandum" and left blank. The engineering data are a table of the compressive strength of wrought and cast-iron columns, the Gordon column formula, a formula for the flexural strength of beams, and tables giving the safe loads of I-beams and deckbeams. The products listed are seven diameters of Phoenix columns, eight depths of I-beams, five of deck beams, three of channels, eleven sizes of equal-legged and six of unequal-legged angles, six sizes of T-bars, miscellaneous shapes and round, square and flat bars. The Phoenix Iron Co. issued the first edition of its handbook, "Useful Information for Architects, Engineers and Workers in Wrought Iron," a book of 124 pages 4x6½ in., in 1873 or 1874 (the book is undated).

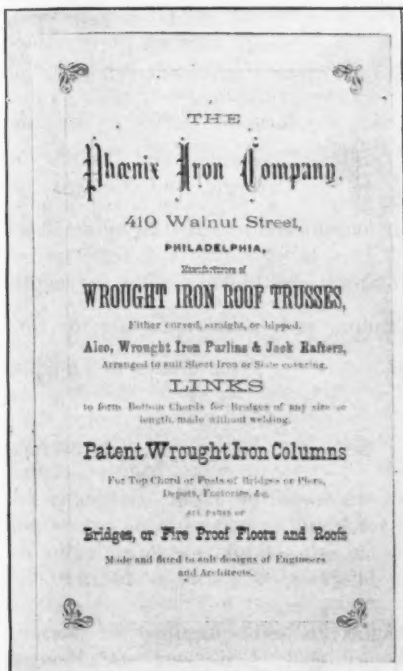

THE
Phœnix Iron Company,
410 Walnut Street,
PHILADELPHIA,
Manufacturers of
WROUGHT IRON ROOF TRUSSES,
Either curved, straight, or tapped.
Also, Wrought Iron Purlins & Jack Rafters,
Arranged to suit Sheet Iron or Slate covering.
LINKS
to form Bottom Chords for Bridges of any size or length, made without welding.
Patent Wrought Iron Columns
For Top Chord or Posts of Bridges or Piers, Depots, Factories, &c.
and parts of
Bridges, or Fire Proof Floors and Roofs
Made and fitted to suit designs of Engineers and Architects.

FIG. 1. THE 1869 POCKET-BOOK WAS A PRICES-CURRENT

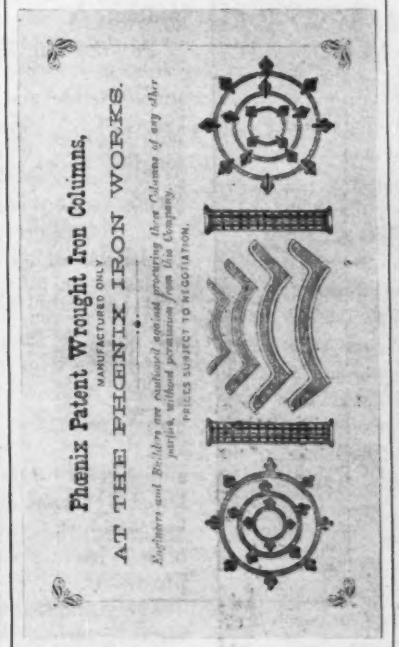

Phœnix Patent Wrought Iron Columns,
MANUFACTURED ONLY
AT THE PHŒNIX IRON WORKS.
Engineers and Builders are cautioned against procuring these Columns of any other parties, without permission from this Company.
PRICES SUBJECT TO NEGOTIATION.

FIG. 2. ILLUSTRATION FACING TABLE OF PHŒNIX COLUMNS

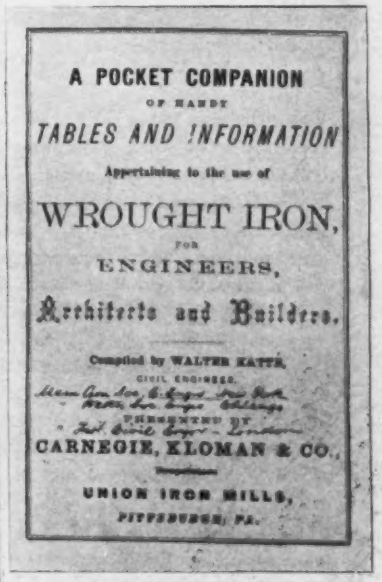

A POCKET COMPANION
OF HANDY
TABLES AND INFORMATION
Appertaining to the use of
WROUGHT IRON,
FOR
ENGINEERS,
Architects and Builders.
Compiled by WALTER KATTÉ,
CIVIL ENGINEER.
PRESENTED BY
CARNEGIE, KLOMAN & CO.,
UNION IRON MILLS,
PITTSBURGH, PA.

FIG. 3. TITLE-PAGE OF FIRST CARNEGIE—From Mr. Katté's own copy

Another early book, the second in chronological order, is entitled "Rolled Iron Beams Made by the New Jersey Steel and Iron Co."; it is dated 1871 and consists of 22 unnumbered printed pages 3¼x5¼ in. The beams listed comprise nine depths and eighteen weights, ranging from a 4-in. beam of 2.01-sq.in. area to a 15-in. beam of 20.02-sq.in. area. The safe load, deflection, correction for lateral deflection, strength as a strut and moment of inertia are given for each beam; also tables of weights of flat, round and square iron and of bolts and rivets. In 1876 the New Jersey Steel and Iron Co. published an enlarged handbook of 81 pages and three plates. Later editions bore the title "Useful Information for Engineers, Architects and Constructors, and Tables of Rolled Beams, Channels, Angles, etc., made by the New Jersey Steel and Iron Co." Pages and plates were added as warranted.

The third book in order of time is the first edition of the widely known "Carnegie." The title page reads "A Pocket Companion of Handy Tables and Information Appertaining to the Use of Wrought Iron, for Engineers, Architects and Builders. Compiled by Walter Katté, Civil Engineer. Presented by Carnegie, Kloman & Co., Proprietors Union Iron Mills, Pittsburgh, Pa." The cover bears the date 1873. The book contains 70 pages, 30 of which are taken up with Carnegie products. The weights, dimensions, properties, safe loads and deflections of beams and channels are fully given. Miscellaneous information and tables complete the rest of the book. Page 14 is headed "Sir Charles Fox's Rules for Proportion of Heads and Pins for Upset Links," and on the next page there is a "Table Showing the Saving in Iron, Effected by the Use of Bolts with Upset Ends."

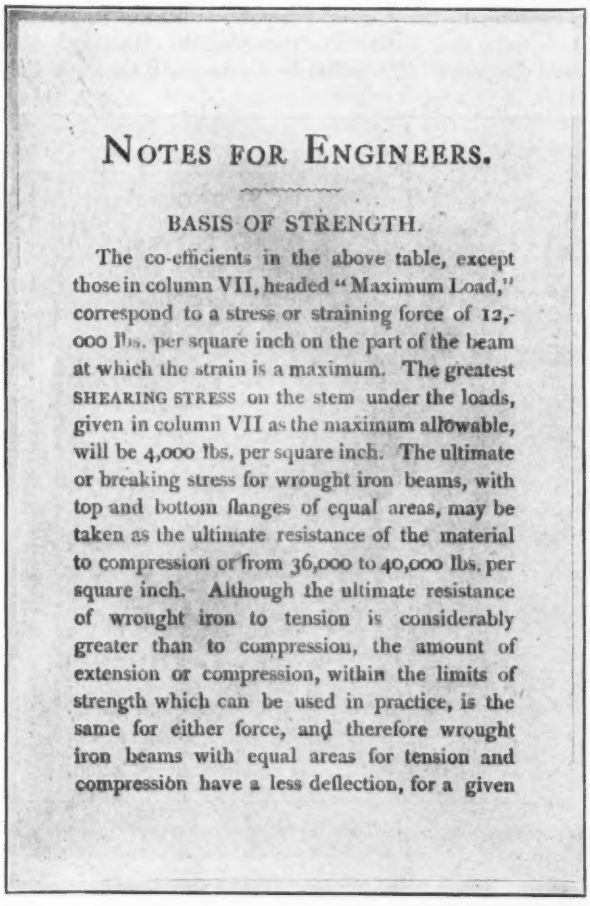
Another book of interest is the Carnegie Brothers & Co.'s "Pocket Companion," second edition, 1876. The first 30 pages are taken up with the table of contents and lithographs of rolled sections; Part First follows with 60 pages giving "Description and Elements of the Union Iron Mills, Rolled I-Beams, Deck Beams, Channel Bars, Angle Iron, T-Iron, etc., etc., with the Tables of Coefficients When Used as Floor Beams, Rafters, or Struts and

*American Bridge Co., 30 Church St., New York City.

[1]The writer is indebted to N. R. McLure, Chief Engineer of the Phoenix Iron Co., for the use of early Phoenix handbooks and to R. B. Woodworth, of the Carnegie Steel Co., for information regarding editions of the Carnegie "Pocket Companion."

Pillars"; Part Second fills 80 pages with "Miscellaneous Information for Engineers, Builders and Mechanics." A limited edition of the "Pocket Companion" was printed for distribution at the Centennial Exposition at Philadelphia. It was given mainly to important personages.

The evolution of a handbook is well illustrated in the long line of editions of this "Pocket Companion." No other handbook has been so widely circulated; of the fifteenth edition (1903) over 100,000 copies were distributed. The seventh edition (1892) contained data on both iron and steel, the profile cuts indicating by distinctive colors what sections were rolled in one or both materials. The eighth edition (1893) showed steel sections only and



NOTES FOR ENGINEERS.

BASIS OF STRENGTH.

The co-efficients in the above table, except those in column VII, headed "Maximum Load," correspond to a stress or straining force of 12,000 lbs. per square inch on the part of the beam at which the strain is a maximum. The greatest SHEARING STRESS on the stem under the loads, given in column VII as the maximum allowable, will be 4,000 lbs. per square inch. The ultimate or breaking stress for wrought iron beams, with top and bottom flanges of equal areas, may be taken as the ultimate resistance of the material to compression or from 36,000 to 40,000 lbs. per square inch. Although the ultimate resistance of wrought iron to tension is considerably greater than to compression, the amount of extension or compression, within the limits of strength which can be used in practice, is the same for either force, and therefore wrought iron beams with equal areas for tension and compression have a less deflection, for a given

FIG. 4. PAGE FROM THE TRENTON 1871 BOOK, A PIONEER STRUCTURAL POCKET-BOOK

marks approximately the end of the use of wrought-iron beams and channels.

Passing from these pioneer books to those of the present day—with a tribute to the excellence of the Pencoyd handbook, "Steel in Construction," no longer published—we find the field now covered by the handbooks of the Bethlehem Steel Co., 1911, 120 pages; Cambria Steel Co., 1916, 513 pages; Carnegie Steel Co., 1916, 434 pages; Jones & Laughlin Steel Co., 1916, 388 pages; Lackawanna Steel Co., 1915, 456 pages; and Phoenix Iron Co., 1915, 248 pages.

The "Catalog of Bethlehem Structural Shapes" is, as called, a catalog rather than a handbook. The Bethlehem company handbook, "Structural Steel," issued in 1907, has not been continued. Only one edition was printed.

The information given in the Phoenix book is confined mainly to the properties of iron and steel. The introduction states, "No attempt has been made to compile a textbook covering the design of steel structures."

A brief comparison of these books may be of interest. They necessarily have much in common, and each manufacturing firm gives prominence to its own products. They contain a wealth of data and information invaluable to the structural engineer. The personal equation always enters into the selection of material for a compilation. Cambria devotes 23 pages to areas and circumferences of circles, giving two tables, one advancing by tenths and another by eighths, for diameters ranging from 0 to 100. Twelve pages are given to square and round bars. Carnegie, Jones & Laughlin and Phoenix give an unusually complete table of the functions of numbers from 1 to 1000. Phoenix devotes 30 pages to an exhaustive table of weights per lineal foot of steel plates from $\frac{3}{16}$x1 in. to 1½x120¾ in. for each $\frac{1}{16}$ in. of thickness and ¼ in. of width.

For the safe load in direct compression on steel columns Bethlehem uses the formula $16{,}000 - 55\frac{l}{r}$ for lengths over 55 radii of gyration and 13,000 for lengths under 55 radii; Carnegie and Phoenix use $19{,}000 - 100\frac{l}{r}$ for lengths from 60 to 120 radii, 13,000 for lengths under 60 radii and $13{,}000 - 50\frac{l}{r}$ for lengths over 120 radii; Cambria and Lackawanna use the Gordon formula, $P = \frac{12{,}500}{1 + \frac{(12L)^2}{36{,}000r^2}}$; Jones & Laughlin uses $16{,}000 - 70\frac{l}{r}$ for lengths between 30 and 150 radii and 14,000 for lengths under 30 radii. Carnegie, followed by Jones & Laughlin, considers loads on column brackets. Both err in using Rankine's formula for eccentric loading to determine the stresses for the case illustrated.

The strength assigned to beams unsupported laterally varies greatly. According to Bethlehem and Phoenix 80% of the tabular strength should be taken for a beam having a span 40 times the flange width without lateral supports. According to Cambria 73% should be taken, while Carnegie and Jones & Laughlin give 43%. Lackawanna makes no mention of beams unsupported laterally. This omission is unfortunate, for the inexperienced are liable to use the full tabular strength for all beams. Carnegie, followed by Jones & Laughlin, gives very convenient tables of the allowable uniform load on beams and channels in pounds per lineal foot.

The subject of grillage foundations is taken up by all except Lackawanna. It is noted that they agree in locating the maximum bending moment of a grillage beam at the center of the beam, correcting a grievous error found in some earlier editions. There is not the same agreement, however, in the determination of bearing plates for beams. Carnegie and Jones & Laughlin include calculations of rolled-steel slabs.

The location of the principal axis of unequal-legged angles is given in Cambria and Lackawanna. For the location of the principal axis of Z-bars it is necessary to refer to earlier editions of Cambria.

Cambria, Carnegie, Jones & Laughlin and Lackawanna give a formula for wind pressure on roofs, but it is the old Hutton or Unwin formula that has long been discredited.

Cambria fills 22 pages with an elaborate analysis of the building laws of 31 cities. This seems longer than necessary, for building codes are changed so often that these pages cannot be quoted as authority. Moreover, a clause in one part of a code is sometimes modified by a clause in another part which a tabulation fails to show. The two pages of "Contents of Storage Warehouses" in Carnegie are original and valuable. Wooden beams and columns receive attention in 21 pages of Cambria and in a dozen of Carnegie and Jones & Laughlin. Cambria and Carnegie give a few pages to reinforced concrete.

The question will here be raised, Why not have a standard notation for beam flexure? Why should Bethlehem and Cambria use such diverse systems? Or why should Jones & Laughlin and Lackawanna differ as they do? At present every textbook on mechanics or stresses is a law unto itself in its notation and is liable to remain so as long as there is no agreement among compilers of handbooks.

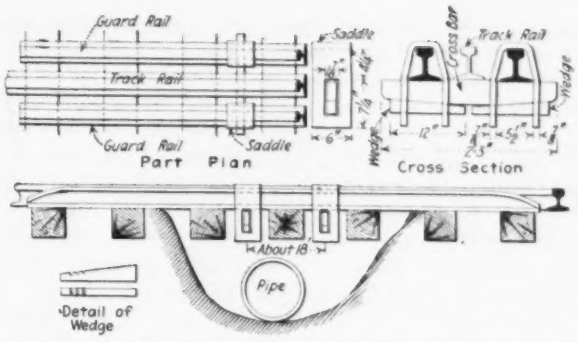
In concluding, attention is called to two leading English handbooks. The "Pocket Companion" of Dorman, Long & Co., Ltd., 1915, xl + 240 pages, is similar to American handbooks and calls for no special remarks. Of course, English terminology is used throughout.

The handbook No. 16, July, 1915, "Structural Steel," of R. W. Skelton & Co., 320 pages 6½x8½ in., is unique in its contents, arrangement, thumb-indexing and typography. It is stated in the introduction, "Except for the mathematical tables or where express acknowledgment is made to the contrary, the contents of this book are entirely original both in substance and form." The scope of the book is confined mostly to structural steel. Alone among the handbooks mentioned it quotes the well-established Duchemin formula for wind pressure on roofs. The "Nomogram" is introduced, and a number of these diagrams are found throughout the book. The notes regarding delivery of steel of the various sections are especially valuable. A few pages are given to "American" standard beams, channels and specifications. The last 20 pages are taken up with photographs of structures fabricated by Skelton & Co.

Supporting Tracks Across Trenches

Digging trenches through railway fills for culverts, pipe lines, etc., usually necessitates placing timbers and blocking under the ties, with increased excavation to put in this timbering. A method devised to reduce the amount and cost of such excavation consists in the use of short guard rails on either side of the track rails, carrying saddles with crossbars that support the track rails, as shown in the drawing.

The guard rails are about 10 ft. long, with ends beveled so as not to catch hanging chains or hose. Pieces of scrap rail can be utilized. These rails are laid on the ties, so as to span the location of the trench. Over each rail is placed a saddle having slots in the vertical legs below the level of the rails. A crossbar of 1¾-in. iron, with bottom sides tapered, is slipped through the legs of the two saddles, and wedges driven beneath it



DEVICE FOR SUPPORTING RAILWAY TRACK ACROSS TRENCHES

in the slotted holes force it to a bearing against the base of the track rail. For a trench 4 ft. wide one support is considered sufficient, while for a 5-ft. trench two supports should be used and the sides of the cut braced to prevent caving.

This device is in service on a number of railways. It is the invention of R. S. Bohannan and is made by the Bohannan Easer Joint Co., of Ensley, Ala.

Barge with Plow Lays Cables 12 Ft. Below Bottom of Channel

By Paul J. Ost*

The City of San Francisco operates four drawbridges over narrow waterways where the regular traffic averages more than two boats per hour. At one of these bridges it was necessary to lay a new submarine signal cable having an outside diameter of 1¾ in., and at another bridge two control and signal cables, each having an outside diameter of 4 in. The channel, spanned by both of these bridges, has not been dredged for some time, and the present mud line is more than 10 ft. above the level to which the channel will be dredged. In order to lay the cable below the dredge line, it was necessary to sink it through about 12 ft. of fairly soft mud. The traffic, the character of the mud and expense made the dredging of a trench out of the question. The Butte Engineering and Electric Co., San Francisco, which had the contract for the work, devised the equipment described and illustrated.

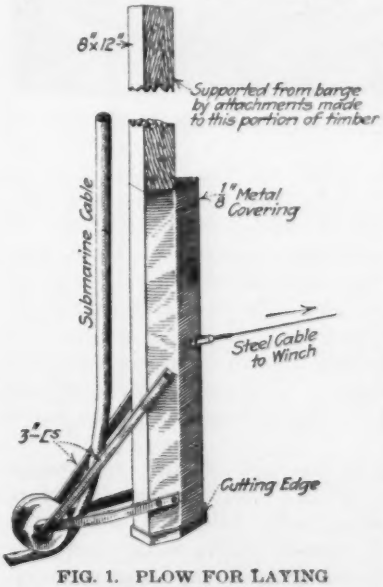


FIG. 1. PLOW FOR LAYING SUBMARINE CABLE

*Electrical Engineer, Bureau of Engineering, City of San Francisco.

The cable reels were loaded on a barge, which was equipped with the plow shown in Fig. 1. This plow consisted of an 8x12-in. timber 36 ft. long, shod for 10 ft. at one end with a cutting edge of ⅛-in. sheet iron formed over a wooden wedge attached to one side of the main timber. Projecting from the timber on the side opposite the cutting edge, a channel-iron frame supported a sheave to carry the submarine cable. The plow was drawn by a steel cable from an electric winch located on the shore. The barge was steadied by two small steel cables run over hand winches set at either end of the barge.

The plow was forced into the mud to the proper depth by means of a chain-block so arranged as to tend to lift the weight of the barge on the plow. When the proper depth was reached, the plow and barge were drawn to the opposite side, and the plow was lifted. This operation was repeated several times to loosen the mud before attempting to lay the cable.

After the mud was sufficiently loosened, the plow was brought to the surface, and the end of the submarine cable was led downward through the sheave to the point of termination at the abutment of the bridge, where it

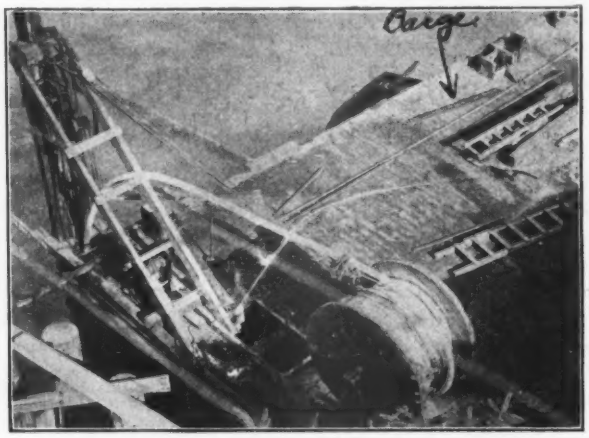


FIG. 2. BIRDSEYE VIEW OF CABLE-PAYING RIG

was made fast. The plow was then lowered into the mud, the cable being paid off the reel at the same time. When the plow had reached the proper depth, it and the barge were again drawn to the opposite side by the electric winch. As the equipment moved, the cable was unreeled into the furrow behind the plow, without a strain of any kind being applied to it. At the far side the plow was raised, the cable being allowed to remain slack, and the sheave was unshipped. The end of the cable was then free to be taken to the terminal box on the bridge abutment.

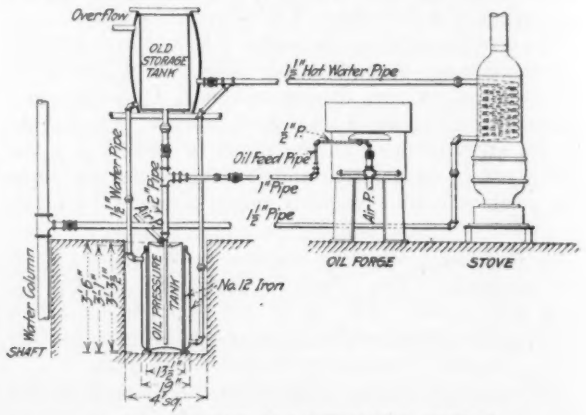
The crew employed on this work consisted of a foreman electrician, an electrician and three laborers. The work could have been handled more easily had sailors been employed in place of common labor, as they naturally are more familiar with handling the ropes and tackle required on a boat. The work was accomplished, however, using the class of labor available.

In this manner it was possible to lay the cable at a known depth without blocking the waterway for more than 30 min. at a time, and at a very moderate cost. All of this work of laying the submarine cable was under the direction of M. M. O'Shaughnessy, City Engineer of San Francisco.

FINE AGGREGATE

Print Profile and Cross-Section Paper on Both Sides is a suggestion offered by Samuel P. Baird, Columbus, Ohio. Mr. Baird says he has recently used a quantity of both kinds of paper in connection with one job and that all but one of the plottings must be discarded. The suggestion is offered in the interest of contractors and engineers, to whom such paper, printed on both sides, would mean money saved.

Oil-Storage for Drill-Sharpening Shop—An oil forge is employed in the steel-sharpening shop of a certain mine in Missouri. Originally it was planned to supply oil for the forge by gravity flow from an overhead tank in the shop, but objections by the underwriters made it necessary to place an oil-pressure tank outside the building, as shown in the



A 50-GAL. FUEL-OIL STORAGE SYSTEM

sketch. The oil is maintained at the proper temperature by means of hot water from a coil placed in a stove. The water is supplied to this coil from the mine-pump discharge column and circulated through a hot-water jacket around the oil tank, rising thence to the upper barrel, which contains a 50-gal. oil tank.

State Highway Bridge Built by County—A steel highway bridge designed for two 15-ton traction engines passing each other was recently completed across the Santa Clara River on the main inland road between Los Angeles and San Francisco. It was built by Los Angeles County on the request of the State Highway Commission, as part of the improvement of main highways in the state. The main span is 200 ft., with a 35-ft. plate-girder approach span at each end. The floor is

A HEAVY ROAD BRIDGE, BUILT BY LOS ANGELES COUNTY FOR THE STATE

1 : 2 : 4 slabwork. The structure was designed by H. E. Warrington, county bridge engineer, and F. H. Joyner, road commissioner. Bridges built under the State Highway Department's request will be maintained by the state and, if destroyed, will be replaced by the state. The call was for bridges of either steel or concrete, assuming 15-ton traction engine loading for the steel bridges and 20-ton machines for the concrete bridges.

Editorials

Why Not Reduce Water Rates?

The mayor of Woburn, Mass., is seeking legislative authority to use $10,000 a year of water income for general municipal purposes. He urges that, although the water-works are owned by the city and produce surplus earnings of $15,000 to $20,000 a year, a legislative mandate requires all the surplus to be used for improvements instead of part of it going into the city treasury as profits and to reduce the city tax rates.

It seems pertinent to ask why not reduce the water rates, if they are producing a profit not needed for operation, capital charges and yearly extensions? Why should the water rates be made high in order that the tax rate may be made low?

Whatever the facts as to profits are at Woburn, some other Massachusetts cities are operating their works at a loss or, at least, letting the works go to rack and ruin through lack of proper management and financing. Reference was made in these columns on Feb. 15, p. 285, to comments on unsatisfactory diversion of water-works funds in Massachusetts cities, as stated in a report to the legislature from the State Department of Health. In a printed copy of this report, just received, it is said that, owing to lack of proper maintenance and renewals, the water-works of a Massachusetts city in which the water-works income had been used for general city purposes had deteriorated to such an extent that it had been necessary "to borrow money for the renewal of the water-works, while the surplus income therefrom was being used for the general expenses of the city—an indirect method of borrowing to meet general municipal expenses." This is certainly adding confusion to confusion. Apparently, that city thought it was really operating its works at a profit and using the profits to reduce taxes.

It is high time that such confusion in American water-works management by municipalities be brought to an end, so that, if it is decided to reduce general taxes at the expense of the water consumer, the result will not be an eventual addition to his tax bill.

Temporary Building Structures Are Often Neglected

Sometimes it is good to have a structure very unsafe, instead of just moderately so. In a case at Lawrence, Mass., many lives were saved because the roof trusses fell down before the building was finished and occupied. A contributory providential cause was a heavy snowstorm.

Like many temporary structures, this one was anything but uniform in its proportioning, and as it happened the weakest parts were very weak indeed. Had the trusses been a little stronger, or had the snowstorm come along a little later, the accident would have been of a more serious kind.

The Lawrence hall is not the first, nor will it be the last, temporary structure to fail. But there is at present one important difference between permanent and temporary structures whose elimination in the future may reduce such accidents: namely, the fact that temporary structures get distinctly less attention from building codes and building inspectors, as well as from designers. The carpenter who puts up a temporary stand or hall by eye and judgment is the first one to introduce an element of risk. But the building law that neglects to specify precisely concerning temporary work, and the inspector who is apt to leave the whole matter on the carpenter's conscience, increase the hazard very greatly. This is particularly true of roofs, for with floors and reviewing stands the full loading is so obvious and definite that at least posts and joists are usually of safe sizes.

There exists a convenient and seductive idea that temporary structures may have a smaller margin of safety than those built to last. How far is this idea justified? How much reduction of safety margin may be allowed? These are nice questions. We believe that the applicability of the idea, insofar as it is justified at all, is very limited. In any event, it may be put down as sound dogma that proper designing and proper inspection are as essential for temporary as for permanent structures.

The perplexing fact that many of these structures are so arranged that their stress distribution is uncertain should not militate against using the conservative principle of figuring the weakest stress distribution, within reason. The hurry governing most temporary work should not lead to neglect of details, or sanction making them weaker than their connecting members. Splices, knees, bracing and bearings should have as careful attention as in a structure built to endure through a generation.

Water-Power Bill Fails in Congress

The ending of the 64th Congress without the passage of the Water-Power bill and other legislation in which engineers are deeply interested was indeed nothing but what had been expected; but it is none the less a deep disappointment, in view of all the labor that has been expended during the past two years in framing legislation that would harmonize conflicting ideas and enable water-power development to go forward. President Wilson, in his appeal to the public on March 4, made special mention of the Water-Power bill, the bill for leasing public mineral resources for development, the Webb bill for facilitating the development of American export business and the bill for reorganizing the Interstate Commerce Commission, as examples of legislation which ought to have been enacted and would have been except for the obstructive tactics of a minority.

Never in the nation's history has it been so clearly brought home to public comprehension that the nation's welfare is dependent on the ability of Congress to do things. Never has the necessity of radical reform in Congressional methods been more clearly demonstrated.

Another Underpaid City Engineer

The civil engineers of Omaha, Neb., according to a press report, are complaining because the city engineer is a member of a local engineering firm, and hint that because of this association an undue proportion of city surveying work is falling to the share of that firm. A local newspaper pointedly remarks: "Other engineers say the possibility of overlooking errors is greater when the city engineer approves work done by his own firm."

The civil engineers of Omaha could accomplish far more for themselves and for their profession if they would direct their complaints and sarcasms at their city government for the miserly way in which it compensates its engineers. The newspaper quoted states that the salary of the city engineer was recently raised from $3000 to $3600 per annum, and of the assistant city engineer from $2100 to $2400 per annum. Fine compensation, indeed, for men whose duties include the control of public-works construction of a rapidly growing city of 165,000 population!

Worcester Sewage-Treatment History

The history of sewage treatment in Worcester, Mass., reviewed briefly elsewhere in this issue, is an epitome of the history of the art in this country for the past three decades. That is not all. After 35 years of study, experimenting and practical operation on a large scale under the best guiding minds of the country, Worcester today is compelled to ask for time in order to make further studies before it decides just how to meet an imperative demand for more complete treatment.

The processes tried at Worcester—some on large and some on a small scale—have been chemical precipitation, slow sand filters, the plain septic tank, contact beds, trickling filters, the Imhoff tank and now, actually or in early prospect, activated sludge. The Imhoff tank and trickling filters would doubtless be adopted today, were it not for the hopes inspired by the latest great promise in sewage treatment—the activated-sludge method.

Broadly speaking, for many years no one has thought of adopting chemical precipitation for new installations. The plain or one-story septic tank also seems to have had its day, except perhaps for small plants or special local conditions. Slow sand filters require material notable for its scarcity in many parts of the country, and they also demand large areas of land not likely to be available at feasible cost near cities of any size. The contact bed soon yielded to the trickling filter, again except under special local conditions.

The early promise of the activated-sludge process was that in a single simple tank, with sludge as the only contact medium and air under pressure as the only agent, sewage could be treated at will to any required degree while the final sludge would be high in nitrates and thus a valuable fertilizer base. The process still has high promise, but it does not seem so simple and self-contained as it did. Neither its cost nor the commercial value of the sludge has yet been so generally and conclusively established as to make further experiments unnecessary for each engineer and each city approaching the process for the first time.

It is to be hoped that Worcester, with its wealth of experimental and practical data on other processes of sewage treatment, will give the activated-sludge process as full a test as may be needed to determine how it will suit local conditions. Another Massachusetts city, Brockton, seems to be about committed to activated-sludge treatment to provide an effluent for its sand filters. Its proposed action is based on careful studies. Should both of these cities build activated-sludge plants, all sections of the country would see the process under large-scale practical tests—a condition much to be wished, since engineers and cities everywhere are waiting for confirmation of their hopes that another decided advance in sewage treatment has been made, one giving at least another successful process to choose from in seeking to meet local conditions, even if it does not prove to be the one all-inclusive, all-sufficient solution of the sewage problem.

Cement Kilns and Blast Furnaces as Producers of Potash

It is a matter of common knowledge nowadays that the world's food supply is dependent on a sufficient amount of nitrates, potash and phosphoric acid in the soil in which crops are grown. These elements are constantly being removed from the soil by the growth of crops; and a large proportion is eventually discharged into the sea through the operation of modern water-carriage sewerage systems.

In order to supplement the slow processes of nature in restoring fertility to the soil through the decomposition of mineral matter, agriculture in all civilized countries has come to rely largely on artificial fertilizers, the chief ingredients of which are the three elements above named. Of these three, nitrogen is obtainable from the air, both by the processes of plant growth and by recently developed electrochemical processes. Of mineral phosphate, the United States has enormous deposits. For potash, however, the United States, in common with the rest of the world, has had to rely upon the mines of Germany.

Since the outbreak of the war, which cut off the supply of potash from Germany, the problem on which thousands of earnest workers have been engaged has been the development of a supply of phosphate from native sources. There are vast amounts of potash contained in certain rocks. Feldspar, for example, contains a large percentage; but methods of concentrating this potash and putting it into marketable shape on a commercial basis are yet to be developed. Within the last few months, however, it has been discovered that the dust discharged from the cement kiln and from the blast furnace, which has hitherto been chiefly important because of the nuisance that it creates, is rich in potash and in a form that makes it directly available for use as a fertilizer.

In *Engineering News* of Dec. 28, Arthur C. Hewitt, Chief Engineer of the Security Cement and Lime Co., of Hagerstown, Md., described the pioneer plant that his company has established for collecting the dust from its cement plant for use as a fertilizer. This plant with its five kilns in operation is producing 20 to 25 tons of dust per 24 hours, containing 5 to 10% of pure potash in the form of a sulphate. At the Security plant the Cottrell process of dust precipitation is used.

There would appear, however, to be a still simpler method of extracting a large part of the dust from cement-kiln flue gases. At the recent annual meeting of

the American Society of Mechanical Engineers a paper was read by Arthur D. Pratt on "Steam Boilers for Utilizing Waste Heat." One section of this paper was devoted to the application of waste-heat boilers to cement kilns. The gases leaving the end of a cement kiln are at a temperature of 1360° to 1800° F. The opportunity for utilizing their heat for generating steam is obvious; but up to the present time, according to Mr. Pratt's paper, only four cement plants in the United States have installed waste-heat boilers. These are the plants of the Cayuga Lake Cement Co., at Ithaca, N. Y.; the Sandusky Co., at Dixon, Ill.; the Burt Co., at Bellevue, Mich.; and the Louisville Co., at Speeds, Ind.

Mr. Pratt's paper describes in detail the large saving effected through utilizing the waste heat for generating steam, and he also devotes some space to the action of the waste-heat boilers in extracting dust from the waste gases. This dust, according to Mr. Pratt's paper, is merely taken back and fed to the kiln again. The dust is largely composed of burned or unburned cement clinker carried along by the blast, and its feeding back into the kiln has saved the use of just so much raw material.

It is evident, however, that the composition of the dust deposited from the kiln gases will be the same whether it is precipitated by the Cottrell electrical process or whether it is deposited in the course of its passage through the boilers and their settings. If the raw materials used at the plants named are as high in potash as those used at the Security plant, it is evident that the dust collected at the boilers should be as valuable for fertilizer in the one case as in the other.

According to the figures given by Mr. Pratt, the dust collected at the Burt plant amounts to about 2½ tons per kiln per day, or about 3% of the total weight of material fed to the kiln. At the Louisville Co.'s plant the boiler setting and the flues connected with the kilns are specially designed with the object of settling out as much dust as possible to avoid collection of dust on the boiler tubes. The dust collected at the Louisville plant amounts to 3.9% of the total weight of the kiln charge. This appears to be a little more than half the amount of dust collected from the kilns at the Security works by the Cottrell process, which Mr. Hewitt gives as 4 to 5 tons per kiln per 24 hours.

From these figures, a Cottrell process plant to treat the flue dust after passing through the waste-heat boilers might be worth while. Such a plant could be considerably smaller and would involve less difficulty in construction and operation than the plant installed by the Security Cement Co., since it would deal with the gases at much lower temperatures, probably 400° to 500° instead of 1300° to 1800°. The cooler gases would occupy a much smaller volume, and there would be less difficulty with the apparatus on account of the intense heat.

The question that naturally arises is where the potash comes from which is thus collected. Mr. Hewitt's paper is silent on this point. An interesting light is shed upon it by a paper entitled "Potash as a Byproduct from the Blast Furnace," by R. J. Wysor, superintendent of blast furnaces of the Bethlehem Steel Co. This paper is published in the January "Bulletin" of the American Institute of Mining Engineers.

It appears that the Bethlehem Steel Co. is collecting the dry dust deposited by the blast-furnace gas passing through the furnace stoves and boilers and has shipped 1073 tons of this dust in the 15 months since Apr. 1, 1915, to July 1, 1916. This is the dust collected from the operation of four 500-ton blast furnaces, and it will be obvious that the amount of potash recovered from the blast furnace is a much smaller percentage of the material fed into it than is the case with the cement kiln.

This is partly due to the fact that at present only a very small percentage of the potash discharged from the blast furnace is saved. An extensive investigation carried out by the Bethlehem Steel Co., of which Mr. Wysor presents the results in his paper, shows that only 1.3% of the potash present in the materials charged into the blast furnace is recovered in the dust now collected. A considerable part of the potash is lost in the slag and in other ways which cannot be prevented, but there are various possible methods by which a much larger proportion of the potash could be recovered, provided it were commercially advantageous to do so. The Bethlehem plant has in fact experimented with a Cottrell dust precipitator and has found it practicable to collect a dust with an average of 10% potash content.

In discussing the source of the potash in the blast furnace Mr. Wysor expresses the opinion that the chief source of the potash is feldspar or clay mixed as an impurity with some of the materials entering the blast furnace. These impurities perform no valuable function in the operation of the blast furnace; on the contrary, the effect of the alkali on the firebrick lining of the hot-blast stoves is exceedingly injurious.

While in the blast furnace clay occurs only as an accidental impurity, in the cement kiln it is one of the main elements in the charge. It can readily be understood therefore why the cement kiln promises a much larger possible output of potash as a byproduct than does the blast furnace. Should the collection of potash as a byproduct become a permanent feature of cement manufacture, it may become worth while to study the chemical composition of different materials available for cement production. It is entirely probable that great variation will be found in the potash content of the various clays and limestones used; and by choosing materials rich in potash, it may be possible to increase materially the profits of a plant from its sales of potash dust.

Of course, any commercial determination of the future possibilities of potash production from the cement kiln will be dependent on the market prices for potash after the German mines are again available to the world. Even though cheap potash from abroad were to make it unprofitable to collect potash from cement works located on the Atlantic Coast, however, it might still be profitable for cement plants in the remote interior, where the freight rate makes imported potash costly, to manufacture byproduct potash to supply the local demand for fertilizers.

There is every reason to believe that the demand for chemical fertilizers to maintain the fertility of soils is destined to increase enormously the world over. Fertilizer manufacture is like cement manufacture in that the value of the product per ton is so low that there is a strong tendency for the manufacture to spread all over the world. It is quite within the possibilities, therefore, that the wide distribution of portland-cement manufacture may have an important relation to the maintenance of soil fertility and the world's food supply.

Letters to the Editor

I. K. Brunel and the Hungerford Bridge

Sir—The anecdotes of I. K. Brunel in "Engineering News," Jan. 13, 1917, p. 68, contain some inaccuracies as to the Hungerford bridge. This bridge did not cross a gorge, but crossed the River Thames at London in a very flat location. Its span was 676½ ft., with side spans of 333 ft. In 1831, Mr. Brunel proposed a suspension bridge over the gorge of the River Avon at Clifton, a suburb of Bristol, and a cable was stretched in 1836; but the scheme was abandoned in 1853 owing to lack of funds. In 1841-45 he built the Hungerford suspension bridge over the River Thames at London, near the site of the present Charing Cross bridge. In 1861 (two years after Mr. Brunel's death) this bridge was removed to make way for a heavier structure. The material was purchased by John Hawkshaw and W. H. Barlow, who were engineers for the revived project of the Clifton bridge at Bristol. As rebuilt by them over the Avon, it had (and has) a span of 702 ft., with a height of 245 ft. above the water; it has no flanking or shore spans. "BRIDGE."

Chicago, Feb. 24, 1917.

Training Teachers of Engineering

Sir—In your issue of Feb. 8 there is an article of exceptional merit by A. M. Shaw, Esq., Consulting Engineer, entitled "Should Not Engineering Teachers Know How to Teach?" It is of such importance that I desire to emphasize its main sentiment and to amplify it by adding a few suggestions of my own.

Mr. Shaw is right when he indicates that one of the principal defects in engineering curricula is a general weakness among the younger teachers. This is due to several causes, of which the following are the most important:

1. Taking men directly from the graduating classes and making them instructors.

2. Adherence to the pernicious habit of excessive "inbreeding."

3. Employing teachers who know nothing about the science of pedagogy.

4. Permitting men to teach who have no natural aptitude for imparting instruction, or who are working mainly for the financial compensation which the work entails.

5. Failure to pay salaries that are large enough to induce capable men to leave engineering practice and adopt pedagogy.

In respect to the first cause, there are two sound reasons for the objection raised, viz.:

A. No one can properly teach engineering whose knowledge has been obtained solely from books; because, in addition to knowing the "why and wherefore," he must be posted concerning the "how and do." In my opinion, it is unwise for any technical institution to employ on its teaching staff any man who has not had, subsequent to graduation, at least three years of practical experience—and most of it in the field.

B. A recent graduate when teaching at his alma mater is on terms of too great intimacy with the students to permit of his having proper influence over them. This is objectionable not only because of the matter of maintenance of discipline but also because students should regard their instructors with a certain amount of respect—which is likely to be lacking if previously there has been close intimacy between them.

As for "inbreeding," or the selection of instructors from the graduates of the school, it is objectionable mainly because it tends toward getting the teaching into ruts and toward the suppression of innovations that would be in the line of improvement. It should be stated, however, that the longer an engineer has been in practice since graduation, the less important is the objection to having him on the teaching staff of the institution where he studied; because by mixing with the alumni of other technical schools his ideas concerning education become broadened, and because, in connection with large enterprises, his contact with the workers thereon gives him an indication of what are the good features and the defects of the various schools of engineering.

Ignorance of the science of pedagogy, as pointed out by Mr. Shaw, is a most serious handicap to the success of any institution where it is permitted to exist; and allowing those to teach who are lacking in natural aptitude or who are governed essentially by sordid motives is a crime.

Failure to pay adequate salaries to instructors, both young and old, is a condition which obtains today in almost all American technical schools. It is their most serious stumbling-block in the pathway of progress, and is an evil which should be corrected with the least possible delay. Technical instructors have always been paid less than their services are truly worth; and the small increases of salaries which have been made of late years have not kept pace with the augmenting cost of living.

J. A. L. WADDELL, Consulting Engineer.

Kansas City, Mo., Feb. 13, 1917.

Sir—The great increase of attendance at our colleges and the failure to secure corresponding increases of income with which to meet the increased demand upon the capacity of the institutions has brought about a condition in education similar to that which in trade has given rise to the department store and in manufacture to the application of efficiency engineering. The profits of the 10-cent stores and automobile factories justify to the business man the adoption of his methods, and this idol of the American people exhibits his wisdom in matters educational by the creation of costly buildings and beautiful grounds and a large corps of inadequately educated and incompetent instructors.

The number of able men available at the rates which are usually paid for instructors, who do practically all of the college teaching in the first two years of the course, is very small. If those responsible for the management of our institutions of learning would publicly admit their failure through lack of funds to properly meet the demand for education the matter would be simplified.

One of the evils resulting from this condition is the development of a class of instructors inclined to turn up their noses at the duties of teaching, but who lay great emphasis on their ability to piece out their incomes in private practice. It is agreed by all that for the young man who aims to become a teacher it is well that he should have practical experience, both for his own sake and for the sake of the institution which he serves and of the students he is to teach. But unless methods of securing such experience are carefully defined by older and wiser men the resultant abuses are very harmful to the students.

No man should be allowed to enjoy the relation of instructor, teacher, or adviser to the most precious product of our country unless he is willing to give himself wholeheartedly to the task of furthering the development of our sons and daughters to the end that they may reach the highest attainable achievements.

What we need is a training of the popular thought to the end that men may strive for ideals rather than for the accumulation of dollars, and if in the present world confusion the value of the dollar is so disturbed that no man can know what it shall be, the reversion to the earlier and finer things of life may be a blessing worthy in some degree of the tremendous sacrifices that are being made. ALBERT J. HIMES.

Cleveland, Ohio, Feb. 15, 1917.

Patented Materials on Federal-Aid Roads—Attention has been called to the inaccuracy of the statement in "Engineering News," Feb. 15, p. 290, in the report of the annual convention of the American Road Builders Association, that "Great interest was aroused by the clause in the regulations for applying Federal aid that none would be given for payment of royalties on patented materials." To save space the clause in question was not quoted in full (it was quoted in "Engineering News," Sept. 14, 1916, p. 521) and only its meaning, as apparently interpreted by those who discussed it, was given. According to the letter of the law, patented materials are not actually excluded. The clause reads:

> No part of the money apportioned under the act shall be used directly or indirectly to pay or to reimburse a state, county or local subdivision for the payment of any premium or royalty on any patented or proprietary material, specification, process, or type of construction, unless purchased or obtained on open, actual competitive bidding at the same or a less cost than unpatented articles or methods equally suitable for the same purpose.

A Base-Support Rail Joint

The rail-joint shown in the accompanying drawings supports the rails by their bases only, and these for a length of only 2½ in. at the center of the joint, instead of throughout the length of the joint. There is no bearing under the head of the rail.

In the cast-steel joint Fig. 1, the base and outer side are formed in one piece. The outer side also is carried up so as to have a lateral bearing against the outside of the rail heads; but the top of the joint is ½ in. below the top of the rail head, so that it is clear of the false flanges of worn wheels even when the rails are worn. In the rolled-steel joint, Fig. 2, the two parts are identical in shape, each forming one side and half the base support. In this joint the lateral member along the rail head is omitted.

The purpose of this design is to hold each rail as an individual member, avoiding the usual feature of splicing the rails so as to form a continuous girder. Thus the joint holds the rails in position at their ends, both vertically and horizontally, without performing the functions of a splice. It has the same strength and resilience as the rails, so that it does not constitute a rigid or hard spot in the track. As the bearing or rail seat is slightly lower at the ends than at the middle (where the rail ends have a permanent bearing), the joint allows for the deflection or wave motion of the rails under load. This is a special feature of the joint, and it is claimed that in this way reverse stresses are eliminated and the load is transmitted through the center of the joint to the tie, without making a fulcrum of the ties and causing rocking or pumping.

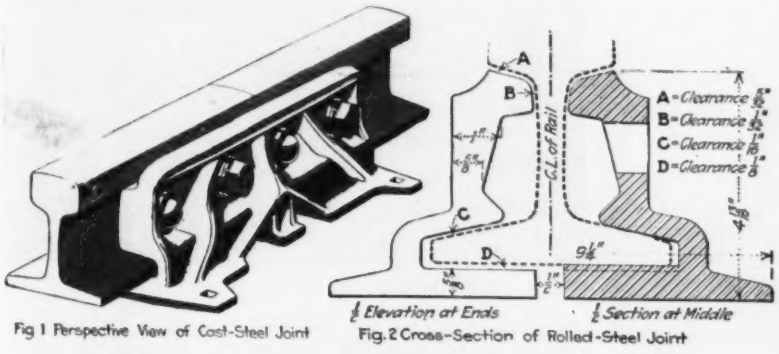


Fig. 1 Perspective View of Cast-Steel Joint Fig. 2 Cross-Section of Rolled-Steel Joint

HINGE TYPE OF RAIL JOINT
The Roach joint is not a splice, but forms a hinge at the rail ends

In the cast-steel joint, the outer or main side-bar (which is formed integrally with the base support) has a clearance of $\frac{1}{16}$ in. from the rail head at the center and $\frac{3}{16}$ in. at the ends of the bar. The bottom of the rail is $\frac{1}{16}$ in. clear of the base member of the joint, except at the middle of the joint. This is the only point of support for the rail, and here its base is tightly gripped by the joint, as shown. The light bar used on the inside of the cast-steel joint does bear against the head of the rail, but only at the middle, its ends being $\frac{1}{16}$ in. clear at both top and bottom. In the rolled-steel joint, it will be seen that this head bearing is eliminated entirely.

With this device the track is best laid with supported joints, having a tie under the center of each joint. It can be used with two-tie or bridge joints, having a tie at each end of the joint, but experience has shown that with the latter arrangement the joint ties remain high. The other ties (especially those of the quarter-points) then have to be raised, while ordinarily it is the joint ties that get low and have to be raised. With the supported or one-tie joint less maintenance is required than with the two-tie joint. The maintenance expense of either form of the joint is said to be very low.

This joint has been used for insulated joints on the St. Louis & San Francisco R.R. for about four years, and as an ordinary track joint it has been in service on other roads for about six years. It has been patented by H. F. Roach, President of the Reinforced Rail-Joint Co., Syndicate Trust Building, St. Louis, Mo.

Legal Decision on Liability of Street Railway for Track Paving

By O. E. Brownell*

In the district court, eleventh judical district, State of Minnesota, St. Louis County, case of City of Duluth, plaintiff, vs. Duluth Street Railway Co., defendant, the court has handed down a decision in favor of the city, which involves points of interest to municipal engineers.

The company's franchise provided among other things that in cases where "other than animal power is used, the company shall be required to pay only so much of the expense of paving the street as is made extra by reason of said railway." The company maintained that it was liable only for the extra cost of laying the pavement around its tracks over what it would have cost to lay the same pavement if the tracks were not there. The city claimed that in addition to the extra cost of paving around rails the company was liable for the cost of extra width of street made necessary by the existence and operation of the railway. If the tracks were not in the street, the city would have paved it 25 ft. wide, curb to curb, and on account of the street railway it was paved 42 ft. wide. The court held that the extra width was made necessary to the extent of 10 ft. for double track and 5 ft. for single track and also that the company was liable for extra expense of paving around tracks. The memorandum of the court contains the following:

1. The court finds as a matter of fact that the additional width of pavement was made necessary by the railway, and it has endeavored to fairly determine the extent thereof. The accuracy of such determination is uncertain. It is necessarily so. If the railway company is liable at all, it is only liable for such additional width "as is made necessary by reason of the railway." Yet there is no sharply defined line of distinction between necessity and convenience. It is impossible to say with absolute certainty that a given width of pavement is necessary and that any width in addition thereto is merely convenient. This matter presents a question of judgment only, upon which experts may and do honestly and excusably differ; and the finding of the court represents only its judgment arrived at with the aid of counsel, from the testimony of experts and others.

2. The parties to this contract must have anticipated that during the 50-yr. life of the charter there would be many changes and improvements in the operation of the railway, involving extra expense of paving; and it was apparently the

*Assistant City Engineer, Duluth, Minn.

purpose of the framers of the instrument to use general language which might cover all items that could not then be foreseen in detail. In the opinion of the court it would be unreasonable to hold that the parties to the transaction did not anticipate that during that 50-yr. period there might be such changes or improvements in engineering methods or in city planning as to create a condition where it must be held that the operation of the railway itself makes additional width of pavement necessary; and if it be true that the parties did anticipate such possibility, they did nothing to indicate any intention that the company should not be liable for extra expense because of such increased width the same as it is liable for extra expense on account of any other item increasing the cost of pavement.

In arriving at the amount of liability of the street-railway company, the court readjusted the unit prices bid by the contractor who did the paving. No difference was bid in price per square yard of paving between the regular paving outside of rails and that between and around the rails. The testimony, however, showed a difference in actual cost, and the railway company was held liable for such cost.

Up to the present time the unit prices bid on contract work have been the final basis for divisions of cost and assessments. In cases of unbalanced bids this has given an incorrect "division of the cost," among the parties sharing it—the property owners, the city and the street-railway company. Under this action it will be proper for the city engineering department to scrutinize all contracts for unbalanced bids and make a fair readjustment for purposes of division of cost and assessment.

Dry Rot in a Derrick Boom Causes Fatal Accident

By Henry Blood*

On Jan. 31, 1917, the boom of a stiff-leg derrick on the Public Auditorium in Portland, Ore., broke near the upper end and dropped a roof truss to the street. Two steelworkers were riding to the roof on the truss. One fell with it and was killed; the other jumped or was shaken off inside the building and escaped serious injury. Three roof trusses (besides the one that dropped) and several roof beams were damaged. The top of the wall was crushed for a short distance, and a section of scaffolding was destroyed. Broken pieces of wood from the end of the boom were found to be seriously affected by dry rot, although the outside appeared to be sound.

The derrick consisted of two stiff-legs placed at right angles to each other, a 30-ft. mast and a 90-ft. boom. The stiff-legs, sills and mast were composed of square timbers about 12x12 in., the bottom of the stiff-legs being about 32 ft. from the foot of the mast. One stiff-leg was placed north and south over roof truss T2, with the mast at the north end and about 40 ft. from truss T4. The other stiff-leg ran east to truss T3 (see Fig. 2). The main part of the boom was 70 ft. long and 15 or 16 in. in diameter at the larger end; it was spliced out to a length of 90 ft. by lapping another round timber of about 40 ft. along the under side and lashing the two together with wire rope at the ends and center of the lap (Fig. 3).

The contractor stated that this timber was five years old and that it had been stored in his open yard when not in use, where it was exposed to the weather. When new, it had been given a coat of linseed oil and one of green paint. He thought that an outside examination would not have indicated unsoundness and that the steelworkers would not have ridden on the truss if they had thought it unsafe.

There were two lifting blocks, one at the end of the main boom and one at the end of the spliced length. The latter had a four-part steel cable, and the same line ran through both, so that the strain was divided about proportionately between them. The hoisting line ran from the lower hoisting block to a sheave close to the end of the boom (see Fig. 3), followed the top of the boom to the mast and passed down through the turning pivot to the engine, which was located on the main floor of the Auditorium.

The boom was 10½ in. in diameter at the tip. It had a vertical slot 2 in. wide and 13 in. long for the hoisting-line sheave, a collar formed of two pieces of 1x6-in. metal with 1¼-in. bolts and heavy shackles for the hoisting and boom-raising blocks. There was a ¼x4-in. strap on each

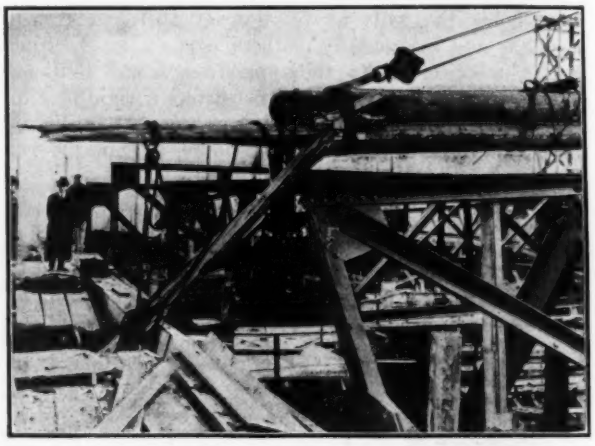


FIG. 1. DERRICK BOOM LYING ON ROOF AFTER FALL

side hooked around the outer edge of the collar and extending back about 3 ft. Four ¾-in. bolts and a 1¼-in. sheave pin ran through both straps and the timber. There was an old horizontal check extending from the tip to a point beyond the inner bolt, and an old vertical crack running both ways from the sheave slot, which divided the end of the stick into four parts. There was also quite a large sound knot near the end. The break that caused the accident was close to the inner ¾-in. bolt.

The smaller roof trusses and beams were piled near the Third St. wall, as delivered. A number had already been raised and set in place, some being as heavy as, or heavier than, this truss T45, which weighs 5100 lb. The wall is 60 ft. high at the point of accident. Truss T45 had been lifted some distance above the wall and other roof framing and turned at right angles to the wall. The boom was at an angle of nearly 45°. Two or three sharp reports like rifle shots were heard by bystanders a few seconds before the truss reached this position. They appeared to come from the end of the boom. The end suddenly snapped off 3 ft. from the tip, the truss dropped on the outer roof beam, slipped down across the wall and fell to the street, carrying away the scaffolding as it fell. The blocks and cable went with it, and some cable was reeled from the drum of the engine. The boom immediately dropped to the roof, striking transversely another boom that was lying over truss T1, swung violently downward

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and split two or three large pieces from the end, one or two of which fell to the ground. Some electric wires on poles nearly as high as the wall were broken by the falling truss. The current was conducted to the roof steel, and several workmen in contact with it received shocks. The 10-in. beam that was struck by the truss was sheared off diagonally through the web at that end. The short end of the beam, hanging to truss T23, can be seen in one of the photographs. Several other beam connections were broken. They had all been bolted temporarily.

An examination of the broken timber showed that it was so affected by dry rot near the end that probably not 25% of the strength remained. Fungus growth was present in some of the splits. There was a thin shell of quite sound wood outside. Its condition could have been determined by boring a few small holes in it or probably by percussion. It had very likely been strained to the breaking point by some previous load. The shape of the end connection and the fact that the spliced piece was not in line with the main boom would cause considerable eccentric stress when the boom was in its lower positions. The brake on the engine may have slipped and produced a shock on the cable; it was seen to slip a day or two later.

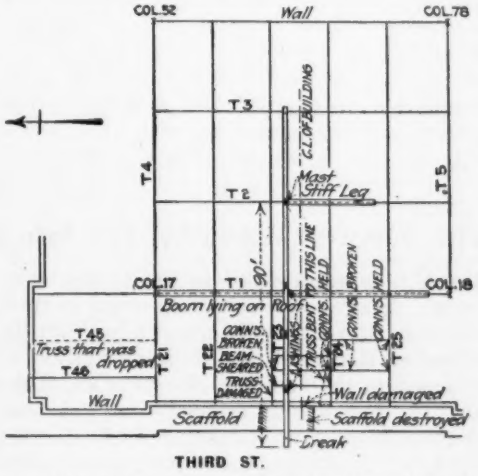

FIG. 2. LOCATION SKETCH OF ROOF AND DERRICK

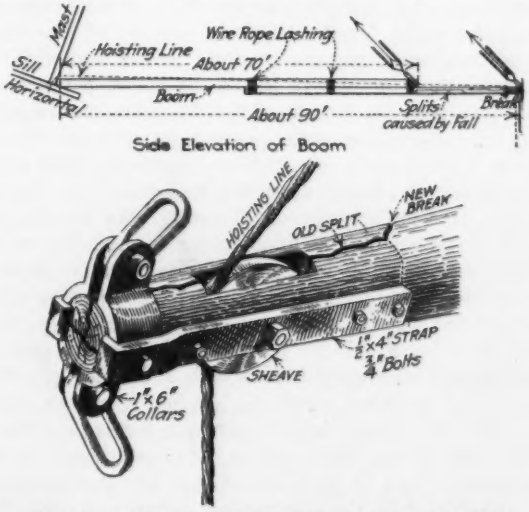

FIG. 3. BOOM SPLICING AND BREAK AT END

This adds to the lesson taught by a former accident on the Pittock Block that derricks and other erection apparatus should be given more attention by their designers and by the contractors and the city or state inspectors. The various parts should be strong enough to resist with a reasonable factor of safety any probable combination of direct and secondary stresses that may come upon them in different positions, and the timbers and cables should be carefully examined before use on each piece of work and at other regular intervals to see that they are in safe condition. Derrick timbers should not be left exposed to the weather for long periods when not in use; they are almost certain to be attacked by dry rot. Painting the outside may hasten and not prevent this.

Steel erectors should, as far as possible, keep the workmen from riding on loads, and they should be made more responsible by law for the proper construction, care and inspection of derricks and other erection equipment. This is not limited to steel structures, but applies to those of other materials; scaffolds on frame buildings are often built insecurely and sometimes cause accidents. Probably most accidents could be prevented by a little care and forethought. But it has generally been the practice to give consistent attention to the design and superintendence of permanent buildings and none to the temporary structures used in erection.

Ontario Municipalities Oppose Canadian Northern Ry. Extension

The projected 84-mile extension of the Canadian Northern Ry. from Toronto to the Niagara frontier was opposed by Sir Adam Beck, of the Ontario Hydro-Electric Power Commission, at the annual meeting of the Ontario Hydro-Electric Railway Association, held in Toronto, Feb. 21. He held that the people must now decide whether or not they want a national electrified railway system. The provincial Hydro-Electric Commission had spent $750,000 in preparing plans and estimates for the hydro-electric radial lines. He asserted that the Canadian Northern had not the means to build the projected line.

The Canadian Northern plans involve an expenditure of $7,000,000. Provision has been made for double tracks through all important centers, maximum grades of ½%, interchange connections with American coal roads, new receiving yards at Niagara Falls, Ont., bridges at Oakville, Bronte, the Desjardins Canal, the River Jordan and (ultimately) across Niagara River.

A letter was read from Sir William Hearst, Premier of Ontario, to the effect that the provincial government would stand behind the association in its protest against any interference with the hydro-radial movement by private corporations, and particularly in its protest against the granting of special privileges to the Canadian Northern Ry. Resolutions were adopted urging the government to proceed with the Chippewa development scheme as rapidly as possible; to amend the act providing for the construction of hydro-radial lines, so as to permit the immediate construction of lines authorized by the people; and protesting against interference by corporations and private interests against provincial projects and requesting the government to pass a remedial act safeguarding the rights of municipalities against the erection of poles and stringing wires without consent of the people.

News of the Engineering World

Atlanta Engineers To Aid City

A Board of Consulting Engineers to give advice and counsel to the city government of Atlanta, Ga., has been authorized by a recently passed city ordinance and members to the number of five have been named by the Affiliated Technical Societies of Atlanta. The appointees are: J. N. Hazlehurst, M. Am. Soc. C. E., G. R. Solomon, M. Am. Soc. C. E., A. M. Schoen, Am. Inst. E. E., C. P. Pool, M. Am. Soc. M. E., and Hal Hentz, M. Am. Inst. Arch.

The board will serve without pay. It is the intention of the city council to call on the board for technical advice and assistance on all the various engineering problems that arise—such as the paving of streets, planning and construction of sewers and sewage purification plants, the extension and development of the waterworks system, the electrical problems, fire protection problems, building laws, etc. Whenever some problem is referred to the board on which they desire the expert advice and cooperation of a specialist in that line, they will call him in and he will give the board the full benefit of a special study of that problem.

Reinforcing the Poughkeepsie Bridge

The famous cantilever bridge across the Hudson River at Poughkeepsie, N. Y., is to be strengthened and altered for the second time in its life, to adapt it to heavier loading. A special feature of the work is that the bridge will be changed from double track to single track, since the main structure could not be strengthened sufficiently to carry the new loading on both tracks. The bridge was completed in 1889 and forms a connection between the New York, New Haven & Hartford R.R. and railways west of the Hudson River.

The Poughkeepsie bridge has a central cantilever span of 546 ft., flanked by two anchor spans of 525 ft., and two cantilever spans of 548 ft.; the latter have anchor arms forming 200-ft. shore spans. The height is about 165 ft. above water level. The length of the bridge proper is 3094 ft., while the steel-viaduct approaches bring the total length to about 6760 ft. As built originally (and completed in 1889), the bridge had two lines of deck trusses on steel towers. These were spaced 30 ft. c. to c. and carried a double-track floor. In 1906 the bridge was strengthened for heavier loading by building a third line of trusses on the center line of the bridge, these being supported on new steel bents within the towers.

With the great increase in engine and train loading of the past few years the bridge could not safely carry these loads on both tracks simultaneously, nor could it be reinforced to such an extent as to do this. The alternatives were to eliminate the possibility of this double loading or to build a new bridge. The former plan was adopted, as the cost will be relatively small; and although the traffic is heavy, it can be handled without trouble over this single-track link.

The principal change on the bridge will be the reconstruction of the floor system, using long and heavy floor-beams that will distribute the load over the three lines of trusses. With the present double-track arrangement each track has an independent floor system. The spans and towers of the approach viaducts will be reinforced, and the new single track will extend over part of the length of these approaches. The rails of the two tracks will be gauntleted over this single-track section, so as to avoid the necessity of switch connections at the ends.

The plans for the altering and reinforcement of the structure were made by Ralph Modjeski, consulting engineer, of Chicago. The work will be done by the Strobel Steel Construction Co., of Chicago, and the material will be supplied by the Fort Pitt Bridge Works, of Pittsburgh. The work must be carried out without interfering with traffic and is to be completed during 1917.

The Denver Water-Works Situation

Attention is again called to the Denver water-works situation, already several times discussed in the columns of *Engineering News*, by the recent filing with the Public Utilities Commission of the City and County of a preliminary report by the Van Sant-Houghton Co. of San Francisco. The Commission originally entered into a contract with this company in July, 1915 (*Engineering News*, July 29, 1915, p. 234). Under the terms of this contract the company was to make a complete report with reference to the proposed construction of a new and independent water plant for the City and County of Denver, it being definitely understood, although not stated in the contract, that the report should be completed prior to May 1, 1916. On Feb. 21, 1916, however, the Commission entered into an option agreement with the Denver Union Water Co., the corporation furnishing water to the city, under the terms of which agreement the citizens were to have the opportunity of voting upon the the purchase of the existing plant upon the termination of litigation now pending before the United States Supreme Court, in which litigation a final determination as to the value of the said plant is involved. (*Engineering News*, Mar. 9, 1916, p. 483.) Under these circumstances the Commission no longer desired such a detailed report as was at first proposed, particularly when it became apparent that the preparation of such a report was going to take much longer than was at first anticipated by the Commission, and on Sept. 15, 1916, a new agreement was entered into with the engineering company to the effect that it should, not later than Oct. 5, 1916, conclude all work under the previous contract and submit a preliminary estimate on the cost of a new water plant. The report was submitted in the latter part of December, 1916.

The main features of the report are the conclusions (a) that it would cost $27,479,500 to construct a new and independent plant for the city, this amount being approximately twice the present value of the existing

plant as determined by the United States District Court and more than twice the amount estimated as the cost of constructing a new plant by other engineers employed by the Commission; (b) that the supply of water in the South Platte River and its tributaries is insufficient for the requirements of the city without the purchase of the water rights now claimed by the Denver Union Water Co.; and (c) that the existing plant should be purchased under the provisions of the agreement of Feb. 21, 1916.

The plans suggested by the Van Sant-Houghton Co. include estimates of

Diversion from Blue River drainage, approximately	$7,500,000
Three large reservoirs, approximately	5,000,000
A concrete-lined aqueduct, approximately	3,000,000
Purification plant, approximately	2,000,000
City distribution system, approximately	10,000,000
Total	$27,500,000

The proposed system is, of course, far more comprehensive and modern than is the existing system, the total reproduction cost of which was estimated by the engineers employed by the Denver Union Water Co. to be $12,718,383, excluding values of water rights, going concern value and development expense.

The report is considered by the Commission as suggestive only and in no respect as final or conclusive. It is hoped that the matters now on appeal before the United States Supreme Court will be passed upon and that the citizens of Denver may have the opportunity of voting upon the purchase of the existing plant before the end of the current year.

Cincinnati Rapid-Transit Advanced

The draft of an ordinance outlining the terms of the lease for the proposed rapid-transit loop that the City of Cincinnati is to build as outlined in *Engineering News*, Apr. 6, 1916, p. 673, was presented to the council at a special meeting, Mar. 3. The first public discussion was at the meeting of the City Club the same day, and other public meetings are to be held soon. The ordinance will then be placed in final form for early passage. The terms of the lease provide for its submission to the qualified electors, and it will be voted on at the same time as the question of the home-rule charter, or on Apr. 17, 1917.

The proposed lease is for a term of 29 years, but the company must accept the theory of an indeterminate franchise. The earnings of the company are to be limited, and the city shall have control of operations and the right of purchase at specified times.

Form American Academy of Engineers

At the suggestion of Secretary Redfield of the Department of Commerce steps have been taken to form an American Academy of Engineers. Gen. George W. Goethals was asked to name ten engineers, who with himself will form the nucleus of the new organization. These ten are to select forty more members and the fifty, as incorporators, will ask Congress for a national charter. It is the intention to limit the membership to one hundred. The ten chosen by General Goethals are: Dr. C. F. Chandler, Professor of Chemistry, Columbia University, New York City; Dr. W. F. M. Goss, President, Railway Car Builders' Association; Dr. Carl Hering, Consulting Electrical Engineer, Philadelphia; Clemens Herschel, Consulting Civil Engineer, New York City; Dr. C. O. Mailloux, Consulting Electrical Engineer, New York City; Dr. S. W. Stratton, head of the Bureau of Standards, Washington, D. C.; Prof. A. N. Talbot, of the University of Illinois; Stevenson Taylor, Vice-President of the Quintard Iron Works Co., New York City; Dr. J. A. L. Waddell, Consulting Civil Engineer, Kansas City, Mo., and Charles F. Rand, Mining Engineer, New York City.

The Standardization of Salaries in all state departments is advocated by Governor James M. Cox in a budget submitted to the Ohio legislature.

The Bond Election to provide funds for rebuilding the Lower Otay dam in California has resulted in the bonds carrying by a comfortable majority.

A Snowslide Killed 15 Men when it destroyed the bunkhouse, compressor house and warehouse of the North Star mine near Hailey, Idaho, in the latter part of February. A fall of 2½ ft. of snow in three days followed by rain resulted in numerous slides in the district.

To Authorize Subway Construction in Pittsburgh, suitable legislation is being sought by the city officials in the state legislature. The bills introduced on their behalf are drawn so as to permit municipal construction of a rapid-transit subway to be operated by a lessor company.

Workmen's Cottages at the municipally owned garbage-reduction works of Dayton, Ohio, are proposed. The cost would be met from a bond issue to cover the cottages and plant improvements, the bonds to be cared for by the revenue from the plant. Six cottages at a reported estimated cost of $1500 each are proposed.

A Railway Collision Killed 20 Persons, according to press dispatches, when the Mercantile Express on the Pennsylvania R.R. was run into shortly after midnight on Feb. 27 by a fast freight at Mount Union, 43 mi. east of Altoona, Penn. The express had stopped to discharge passengers when the collision occurred. The three steel sleepers were telescoped but remained on the tracks; six of the freight cars laden with coal were thrown down a 40-ft. fill.

Reinforced-Concrete Pipe for Sewers has been used at Vincennes, Ind., for all storm-water sewers of 30-in. diameter and over, the maximum diameter being 66 in. No mechanical bond other than cement grout was used at the joints. The concrete for the pipe was a 1:5 mix of portland cement with sand and gravel. The reinforcement consisted of wire netting of triangular mesh. This pipe proved very strong, one 66-in. section being tested to 34,000 lb. for 24 hr. without destroying it. It was made near the work by Howard Schurmann, of Indianapolis, Ind., under the direction of H. T. Watts, City Engineer.

Los Angeles County Flood-Control Bonds to the amount of $4,500,000 came to vote on Feb. 20 in a hotly contested election. The official count showed a majority of 51 for the bonds, but there may be a recount. The project voted on was one for which plans were made by J. W. Reagan, Engineer of the Los Angeles County Flood-Control District, as outlined in "Engineering News" of Jan. 25, 1917. An earlier report, by a commission of engineers, recommended works estimated to cost $16,500,000 ("Engineering News," Feb. 10 and 17, 1916). A board of engineers consisting of J. H. Quinton, Charles T. Leeds and S. A. Jubb, appointed by the City Council, Chamber of Commerce and Municipal League, made a report on the Reagan plans and estimated the cost of the works contemplated in those plans as $12,518,200, instead of $4,450,000, and in addition held that portions of the Reagan plans were inadequate.

A County-Manager Charter for San Diego County, California, was defeated 2 to 1 on Feb. 27, only some 30% of the registered vote going to the polls. The county manager would have been the chief executive of the county and ex-officio purchasing agent, road commissioner and surveyor. He, in common with numerous other executive officers, would have been appointed by a board of nine supervisors, elected at large but representing specific districts. Another feature of the proposed charter was a civil-service commission. A local correspondent accounts for the defeat of the charter as follows: "The general sentiment appeared to be that the charter was the dream of theorists and presented too large an opportunity for building up a political machine controlled by one man, the county manager. Strenuous objection was also made on the ground that it deprived voters of their rights to elect numerous county officials which the new charter would make appointive."

The Third Annual Conference on Engineering Coöperation will be held in Chicago on Thursday, Mar. 29, at the rooms of

the Western Society of Engineers. The report of a subcommittee prepared subsequent to the meeting of Nov. 21, 1916, at Cleveland, Ohio, has been formulated and is in substance as follows: The work of the national engineering societies should be promoted, but greater stress should be laid upon the development of local engineering societies. Each local engineering society should be self-governed and free from dictation or control by any other association. Local societies should give special attention to the needs of the younger members. Each local engineering society should adopt and frequently make application of a code of ethics. The enforcement of such a code is essential to the well-being of a community as well as to the protection of professional men. An employment bureau should be organized and operated in coöperation with all engineering societies. Each local society should devote time and thought to local, civic, state and national affairs that influence engineering progress and should take an active part in considering proposed new laws.

PERSONALS

H. E. Wood, recently with the St. Louis Screw Co., St. Louis, Mo., is now with the Decatur Bridge Co., Decatur, Ill.

George A. Wardlaw, Editor of the "Electrical Record" since 1910, has resigned to engage in literary work on his own account.

S. L. Rice, Office Engineer of the Delaware, Lackawanna & Western R.R. at Hoboken, N. J., has resigned and the office has been abolished.

Cass L. Kennicott, inventor of water-softening and filtration apparatus, Chicago, Ill., has become associated with Permutit Co., New York City.

H. M. Doughty has been appointed Assistant to the Chief Engineer of the Delaware, Lackawanna & Western R.R. and will have charge of valuation, general drafting office and other special duties.

Charles W. Martin, Assoc. M. Am. Soc. C. E., Engineer, Bridge Division, City of St. Louis, Mo., has resigned to become Secretary of the Woermann Construction Co., Century Building, St. Louis.

Raymond G. Brown, Structural Engineer, Columbus, Ohio, has joined Roy Sims and H. F. Reichard, Architects, under the firm name of Sims, Reichard & Brown, for the general practice of architecture and structural engineering.

Hobart L. Cory and **Francis W. Du Bois** announce the incorporation of Cory & Du Bois, Civil Engineers, Baker, Mont. The new firm will specialize in water-supply, sewerage and sewage-disposal and other municipal work.

M. J. Connerton, formerly Roadmaster of the Cincinnati, New Orleans & Texas Pacific Ry., at Danville, Ky., has been appointed Engineer of Maintenance-of-Way, Southwest district, Southern Ry., Lines West, with headquarters at Chattanooga, Tenn.

P. W. Clancy has been appointed Nebraska representative of the Kansas City office of the Portland Cement Association. He was formerly engaged in municipal work and as Resident Engineer on construction for the Canadian Northern Ry. and Union Pacific Ry.

J. M. Weir, former Assistant Engineer of the Chicago, Rock Island & Pacific Ry. and recently Division Engineer of the Kansas City Southern Ry. at Pittsburg, Kan., has been promoted to be Chief Engineer of the Kansas City Southern, with headquarters at Kansas City, Mo.

William R. D. Hall, Statistician of the Pennsylvania State Highway Department and Editor of the "Pennsylvania Highway News," has resigned to become Manager of the Publicity Bureau of the Philadelphia Chamber of Commerce. He has been with the State Highway Department since 1912.

C. I. Felps has been appointed Field Engineer at the Kansas City office of the Portland Cement Association, with headquarters at Wichita, Kan. He was formerly connected with the Highway Department of Kansas and more recently with the bridge department of the Kansas City Terminal Railway Co.

H. S. Owen, formerly Principal Assistant to the Chief Engineer of Construction of Streets and Sewers, St. Louis, Mo., has accepted the position of Field Engineer at the Kansas City office of the Portland Cement Association. His new work will be confined to eastern Missouri, with headquarters in St. Louis.

R. L. Slocum has been appointed Assistant Superintendent of Mill No. 5 of the Universal Portland Cement Co., at Universal, Penn. He is a graduate of Pennsylvania State College, class of 1905, and has been with the Universal Portland Cement Co. since 1907 and had charge of the construction of the plant at Universal.

William H. Corddy, recently with the W. J. Sherman Co., Toledo, Ohio, and formerly Assistant Engineer, Baltimore Sewerage Commission, has joined the staff of Gannett, Seelye & Fleming, Consulting Engineers, Harrisburg, Penn., as Assistant Engineer on the Mill Creek flood control and Erie sewage-treatment investigation. He is a 1911 graduate of Lehigh University.

E. H. Shipman, M. Am. Soc. C. E., Superintendent of the Lehigh & New England R.R. and Canal Superintendent of the Lehigh Coal and Navigation Co., South Bethlehem, Penn., has been promoted to be Chief Engineer of the Lehigh & New England in charge of engineering, construction and valuation. **C. W. Brown,** Assistant Superintendent, succeeds Mr. Shipman as Superintendent.

John C. Payne, of Trenton, N. J., has been appointed Chief Engineer of the New Jersey Board of Commerce and Navigation, succeeding B. F. Cresson, Jr., M. Am. Soc. C. E., resigned, as noted elsewhere. Mr. Payne has been Assistant Engineer of the Board and for many years was Engineer of the Board of Riparian Commissioners

C. W. Huntington, recently Vice-President and General Manager of the Minneapolis & St. Louis R.R., Minneapolis, Minn., has been elected President of the Virginian Ry., to succeed Raymond Du Puy, resigned, as noted elsewhere. Mr. Huntington is a native of Newark, N. J., and is a former General Superintendent of the Central Railroad of New Jersey. His headquarters will be in New York City.

Raymond Du Puy has resigned as President of the Virginian Ry., effective about May 15. He is a graduate of Georgetown University and began railway work in 1877 as a water boy on the Missouri, Kansas & Texas Ry. For three years he was Assistant Engineer on the Missouri Pacific Ry. For four years he was Chief Engineer and Superintendent of the Tioga Ry. He has been President of the Virginian Ry. for two years.

J. Albert Holmes, M. Am. Soc. C. E., has been appointed Resident Engineer on the so-called Bridgewater developments of the Western Carolina Power Co., for the J. G. White Engineering Corporation, Consulting Engineers of the work. Three large earthfill dams are being constructed by the methods employed on the large earth dam at Somerset, Vt., on which work Mr. Holmes was Resident Engineer. His address is Construction, Burke County, N. C.

Clark R. Mandigo, Assoc. M. Am. Soc. C. E., formerly Assistant City Engineer of Kansas City, Mo., has resigned as Assistant Engineer of the Portland Cement Association to accept the position of Consulting Engineer for the Western Paving Brick Manufacturers Association, Dwight Building, Kansas City, Mo. He will have charge of the Service and Promotional Department for the Association, which operates over most of the territory between the Mississippi River and the Rocky Mountains.

Benjamin F. Wood, M. Am. Inst. E. E., for 16 years Electrical Engineer, Pennsylvania R.R., and for the past three years Vice-President and Chief Engineer of the United Gas and Electric Engineering Corporation, announces the organization of B. F. Wood, Engineers, Inc., Woolworth Building, New York City. The new firm will investigate, design, construct and supervise engineering works in power development, transmission, railroad electrification, electric railway and lighting systems and industrial plants.

Harrison W. Craver, Librarian of the Carnegie Library of Pittsburgh, Penn., has resigned to become Librarian of the United Engineering Societies Library, New York City. He is a graduate in chemistry of Rose Polytechnic Institute and for seven years was head of the Technology Department of the Carnegie Library. He has been Librarian for the past eight years. He is a member of the Engineers Society of Western Pennsylvania, the American Chemical Society, and he is a vice-president of the American Library Association.

B. F. Cresson, Jr., M. Am. Soc. C. E., has resigned as Chief Engineer of the New Jersey State Board of Commerce and Navigation to become Consulting Engineer, with offices at 30 Church St., New York City. For a number of years Mr. Cresson was First Deputy Commissioner of the Department of Docks and Ferries of the City of New York. He will specialize in harbor works, piers, docks, bulkheads, reports on harbor improvement, etc., problems of coast protection and subaqueous tunnel work. He will be retained by the New Jersey Board of Commerce and Navigation as Consulting Engineer.

E. E. Kerwin, recently General Superintendent of the Minneapolis & St. Louis R.R., Minneapolis, Minn., has been elected Vice-President in charge of operation of the Virginian Ry.,

with headquarters at Norfolk, Va. He was born in 1861 at Turner, N. Y., and entered the railway service at 10 years of age as a water boy with a section gang on the New York, Lake Erie & Western R.R. At 22 he became an agent and operator. He was associated with C. W. Huntington, the new President of the Virginian Ry., as Superintendent of the Central R.R. of New Jersey, before they both went to the Minneapolis & St. Louis.

Prof. R. C. Carpenter, M. Am. Soc. C. E., having reached the retiring age at the end of the present college year, will sever his active connection with Cornell University at that time. In accepting his resignation, the Committee on General Administration of the Board of Trustees adopted the following resolution:

Resolved, That the Trustees, in accepting the resignation of Professor Carpenter, express their high appreciation of his services to the university for nearly 30 years. As a pioneer in the field of experimental engineering he is held in the highest esteem by all mechanical engineers, and by his writings in this field he has made an assured place for himself in the annals of his profession. As a teacher and investigator he is affectionately remembered by many generations of students, and his retirement from the Faculty of Sibley College will be viewed with great regret by all his colleagues.

Professor Carpenter expects to maintain his activities in the fields of engineering investigation and research.

Paul P. Whitham, Assoc. M. Am. Soc. C. E., Consulting Engineer, Seattle, Wash., has been selected by the Bureau of Foreign and Domestic Commerce, United States Department of Commerce, to make a study of the existing and proposed port and transportation facilities of Russia and the Far East. An itinerary has been decided on which will include Russia, China, Japan, Philippines, French China, Federated Malay States, East Indies, Burma, India and Australia. The investigation will cover ports and their equipment, the railways, canals and river navigation, as well as intelligence communication facilities. The second object of the investigation is to get together reliable information on proposed transportation extensions and improvements, particularly in China and Asiatic Russia. Such information, the Bureau thinks, will be of great value to American investors, engineers, contractors, manufacturers and dealers in port, railway and other transportation equipment. The third object of the proposed study is to supply data and suggestions to American port authorities, engineers and transportation men generally. Mr. Whitham will visit a number of cities in this country before going to the East and expects to confer with shipping men, engineers and contractors, investment bankers, exporters and trade organizations, manufacturers of freight-handling facilities and others who are interested in the investigation. He expects to be abroad about two years

OBITUARY

Walter Katté, M. Am. Soc. C. E., one of the founders of the Western Society of Engineers, died at his home in New York City, Mar. 4, in his 88th year. He was born and educated in England and came to the United States in 1849. His first work in this country was in railway work in the Middle West. From 1857-1858 he was Resident Engineer of the Pennsylvania State canals, and afterward was engaged in railway construction. During the Civil War he was with the Engineer Corps of the United States Army. He was engineer in charge of erection of the Eads bridge over the Mississippi River at St. Louis, and for 10 years was Engineer and Secretary of the Keystone Bridge Co., Pittsburgh, Penn. He was the first Chief Engineer of the New York Elevated R.R. From 1886 to 1899, when he retired, he was Chief Engineer of the New York Central & Hudson River R.R. He was one of the oldest surviving members of the American Society of Civil Engineers, his membership dating from 1868. He was also a member of the Institution of Civil Engineers of Great Britain.

Ernest L. Ransome, Assoc. Am. Soc. C. E., a pioneer in the reinforced-concrete industry, died Mar. 5 at his home in Plainfield, N. J. He was born in Ipswich, England, 73 years ago, and in 1859 was entered as an apprentice in his father's factory. The concrete industry was then confined largely to the manufacture of artificial stone for ornamental purposes. The father, Frederick Ransome, had patented an artificial stone in 1844. A company was formed in England as the Patent Concrete Stone Co., and in 1870 the process was introduced in America by the Pacific Stone Co., of San Francisco, Calif. Of this company Mr. Ransome was for four years Superintendent. At that time the concrete industry on the coast was slowly developing, with imported portland cement at $9 per bbl. His first patent in this country was during this period, and this patent was for a method of concrete construction designed to prevent the cracking of the concrete over iron beams in concrete arch floor construction. His most famous patent, perhaps, was that granted in 1884 for the now familiar square twisted bar, for use as reinforcing steel. He had long experimented with concrete mixers and in 1884 took out his first mixer patent. His later career is intimately connected with the rise of reinforced concrete for structural purposes, and his name will ever be closely associated with the history of the concrete industry.

ENGINEERING SOCIETIES

NATIONAL BRICK MANUFACTURERS' ASSOCIATION.
Mar. 5-10. Annual meeting in New York City at McAlpin Hotel. Secy., T. A. Randall, Indianapolis

CENTRAL ELECTRIC RAILWAY ASSOCIATION.
Mar. 8-9. Annual meeting in Indianapolis. Secy., A. L. Neereamer, Indianapolis.

NEW ENGLAND RAILROAD CLUB.
Mar. 13-17. Annual meeting in Boston. Secy., W. E. Cade, 683 Atlantic Ave., Boston.

VERMONT SOCIETY OF ENGINEERS.
Mar. 14. Annual meeting in Burlington, at Hotel Vermont. Secy., G. A. Reed, Montpelier

WISCONSIN ELECTRICAL ASSOCIATION.
Mar. 15-16. Convention in Milwaukee. Secy., George Allison, First National Bank Building, Milwaukee.

NATIONAL RAILWAY APPLIANCES ASSOCIATION.
Mar. 20. Annual meeting in Chicago at Coliseum. Secy., C. W. Kelly, Kelly-Derby Co., Chicago.

ILLINOIS GAS ASSOCIATION
Mar. 21-22. Annual meeting in Chicago. Secy., Horace H. Clark, 1325 Edison Building, Chicago

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 20-22. Annual meeting Congress Hotel, Chicago. Secy., E. H. Fritch, 900 South Michigan Ave., Chicago

ST. LOUIS RAILWAY CLUB
Apr. 13. Secy., B. W. Frauenthal, Union Station, St. Louis.

DETROIT ENGINEERING SOCIETY.
Apr. 21. Secy., D. V. Williamson, 46 Grand River Ave., W., Detroit.

SOUTHWESTERN ELECTRICAL AND GAS ASSOCIATION.
Apr. 26-28. In Dallas. Secy., H. S. Cooper, 405 Slaughter Building, Dallas, Tex.

The Portland Cement Association will hold its spring convention in San Francisco, Apr. 16 to 18, at the Palace Hotel.

The Chattanooga Engineers' Club, organized in August, 1916, has elected the following officers for 1917: President, J. Y. Bayliss; vice-president, J. A. Fairleigh; secretary, A. F. Mellen. The society holds monthly meetings and bimonthly lunch meetings.

The Central Railway Club is holding its twenty-seventh annual dinner on Mar. 8, in Buffalo, at the Hotel Statler. The speakers will be General Goethals and Eugene Chamberlin, with C. E. Denny as toastmaster. The secretary is Harry D. Vought, 95 Liberty St., New York.

The Committee on Engineering Cooperation will hold a third annual conference on Thursday, Mar. 29, in Chicago, at 1735 Monadnock Block. The report of the subcommittee, prepared at a meeting on Nov. 21 in Cleveland, will be presented. On the following day a dinner will be held to which all the engineers in Chicago are invited.

The New York State Association of Architects held its annual convention on Feb. 16 in Syracuse. In the course of the meeting resolutions condemning the location of institutions on the Croton watershed and the location of the Washington power house were adopted. Another resolution approved the proposal made by the National Conference on City Planning that a State Bureau of City Planning be founded. The new officers of the association are: President, Frank H. Quinby; vice-president, Edwin S. Gordon; secretary, Leon Stern, Rochester.

The Ontario Municipal Electric Association held its annual meeting in Toronto on Feb. 15. Sir Adam Beck, chairman of the Ontario Hydro Electric Power Commission, predicted that in five years the capital invested in the system—at present approximately $41,000,000—would have increased to over $100,000,000, due to the growing demand for power. In the munitions industry, between 400 and 500 plants are operated by hydro-electric power. These plants require 80,000 hp. and employ 40,000 people. Efforts are being made to provide for the requirements of eastern Ontario by securing a large block of power from the Cedar Rapids Power Co., but the permanent solution of the Eastern problem cannot be found until the waterways on the St. Lawrence are deepened. Resolutions were adopted urging the Provincial Government to permit hydro-electric associations to submit by-laws directly to the people where the local councils refused consent to permit municipalities to supply light and power to suburban districts, and to safeguard the rights of municipalities against blanket powers conferred upon power corporations by amend-

ing their charters. Officers were elected as follows: President, Mayor Thomas Church; vice-presidents, W. K. Sanderson and Controller Ellis, of Hamilton; secretary, T. J. Hannigan, Guelph, Ont.

Appliances and Materials

Portable Detachable Boat Motor

A light detachable electric-power unit for propelling small boats has been placed on the market by the Jewel Electric Co., of 112 North Fifth Ave., Chicago. A high-speed vertical motor and transmission shaft are carried by a telescopic supporting tube that is clamped to the stern. A horizontal-shaft propeller is driven through gearing, and the boat is steered by a tiller handle that turns the propeller bracket. Energy is taken from a six-volt storage battery. The outfit sells for from $89 to $105, depending on the size of the storage battery desired.

* * *

Huge Single-Roll Crusher

A single-roll rock crusher of the Fairmount type, weighing 225 tons, made by the Allis-Chalmers Manufacturing Co., has been installed at the limestone quarry of the Michigan Alkali Co., at Alpena, Mich. This particular installation is the largest of this type to date. The crushing roll is horizontal, as shown, and is provided with projecting teeth in staggered rows upon the face. The crushing is done against an anvil plate, built up in vertical sections. These sections are hollow steel castings, strung upon a shaft and having the lower or jaw ends carried by a cross-beam which is held by diagonal anchor bolts, as shown. Heavy springs on the ends of these bolts allow the jaw to give slightly under excessive pressure and so prevent breakage. The roll on the Alpena crusher has a cast-steel shell 7½ in. thick, with teeth of manganese steel keyed in slots. This shell is keyed upon a cast-iron spider, which in turn is keyed to a heat-treated steel shaft 20 in. in diameter at the bearings. On the shaft is a 175½-in. gear wheel, driven by a 34-in. pinion on a countershaft carrying a 10-ft. belt pulley with 37-in. face. This is belted to a 250-hp. motor, the distance between motor shaft and pinion shaft being about 18 ft. The motor runs at 580 r.p.m., the pinion at 120 r.p.m. and the crushing roll at 23 r.p.m. The machine is mounted on a massive concrete base.

The main part of the hopper is of cast steel, 7x12 ft. at the top. Above this is a structural-steel hopper into which the rock is dumped from standard-gage quarry cars, which are of 12 to 14 tons capacity. Rocks 5x7 ft. can be handled. The crusher is adjusted for a 7-in. product and delivers about 7000 tons of broken stone per 10-hr. shift.

The two principal points in which the Fairmount crusher differs from earlier roll-type crushers are (1) the use of an anvil gradually approaching and extending under the roll, and (2) the use of a roll having part of the knobs or studs higher than the regular ones. The first feature increases the size of the opening where the stone is crushed against the anvil plate. In regard to the large or slugger knobs, it has been found that with knobs of uniform height the crusher is not suitable for breaking large stone. This was discovered on the original machine. It was verified recently, to settle a dispute, by fitting a roll with knobs of uniform size. This would do very good work on small pieces of stone which could be gripped between the roll and the anvil, but large blocks of stone were not crushed at all, and it was necessary to shut down the crusher and lift them out.

The first crushers of this type were installed in 1911 at the plant of the Casparis Stone Co., at Fairmount, Ill., where two of the machines were started in 1912. It is stated that single-roll crushers had been used prior to that time for crushing the smaller size of stone loaded by hand. They were not suitable for crushing the large-sized rock loaded by steam-shovels, however, as the opening between the roll and the concave breaker plate was not sufficient to allow large pieces of stone to be gripped, and no provision was made for sledging the stone on top of the roll.

The crusher is placed in a building on the floor of the quarry, the center line of the roll being about 45 ft. below the ground. A cable incline with two balanced 8-ton skips delivers the stone to a rotary screen above an elevated storage bin on the surface. The paved chute from the crusher to the loading pit of the skips is closed by motor-operated sliding doors parallel with the incline. These are operated automatically by means of tripping levers on the skips.

This machine was designed under the direction of R. C. Newhouse, engineer of the crushing and cement machinery department of the Allis-Chalmers company.

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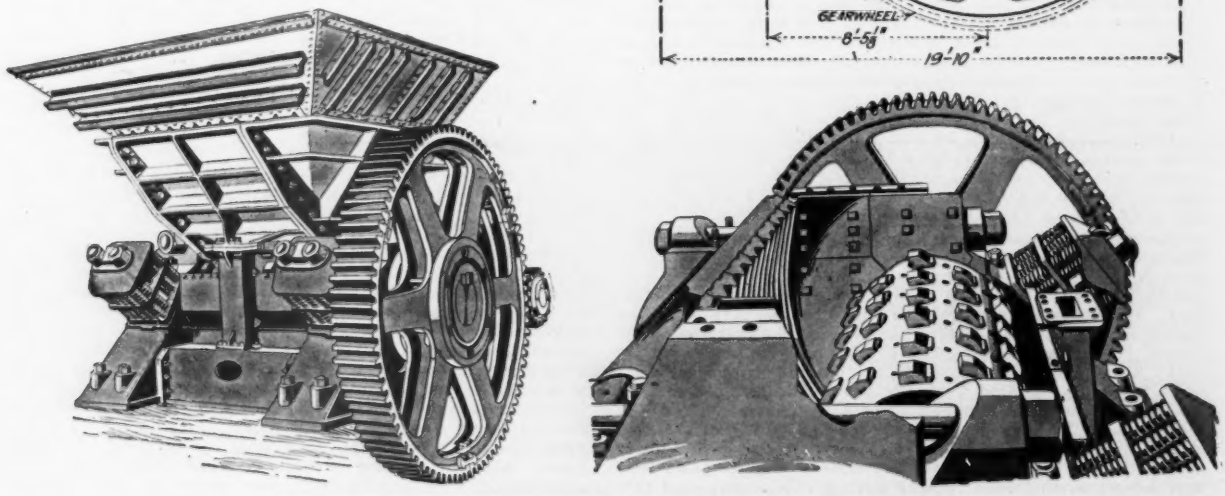
Liquid Boiler-Scale Remover

A liquid intended to be injected into steam boilers to loosen adherent scale is being introduced by the Perolin Railway Service Co., of St. Louis, Mo. This material, bearing the trade name "Perolin," is not a boiler compound, but is a "viscous mineral" that penetrates cracks in the scale and later expands, forcing off the coating. It is claimed that the material, once on the plates, conducts heat, prevents adhesion of precipitated solids and prevents corrosion.



TWO VIEWS AND SECTION OF ALPENA ROLLER ROCK CRUSHER